# Power Engineering

JUNE, 1953

Volume 57, No. 6 Circulation of this issue 32,110

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# FROM 1 HP. UP...

# At JOPPA, all motors

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83 on pumps of all types

20 on fans — induced and forced draft, and ventilating

6 on air compressors

69 on crushers, conveyors, coal feeders, etc.

13 on winches, cranes, hoists

11 on miscellaneous service

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**MOTOR TYPES include:**
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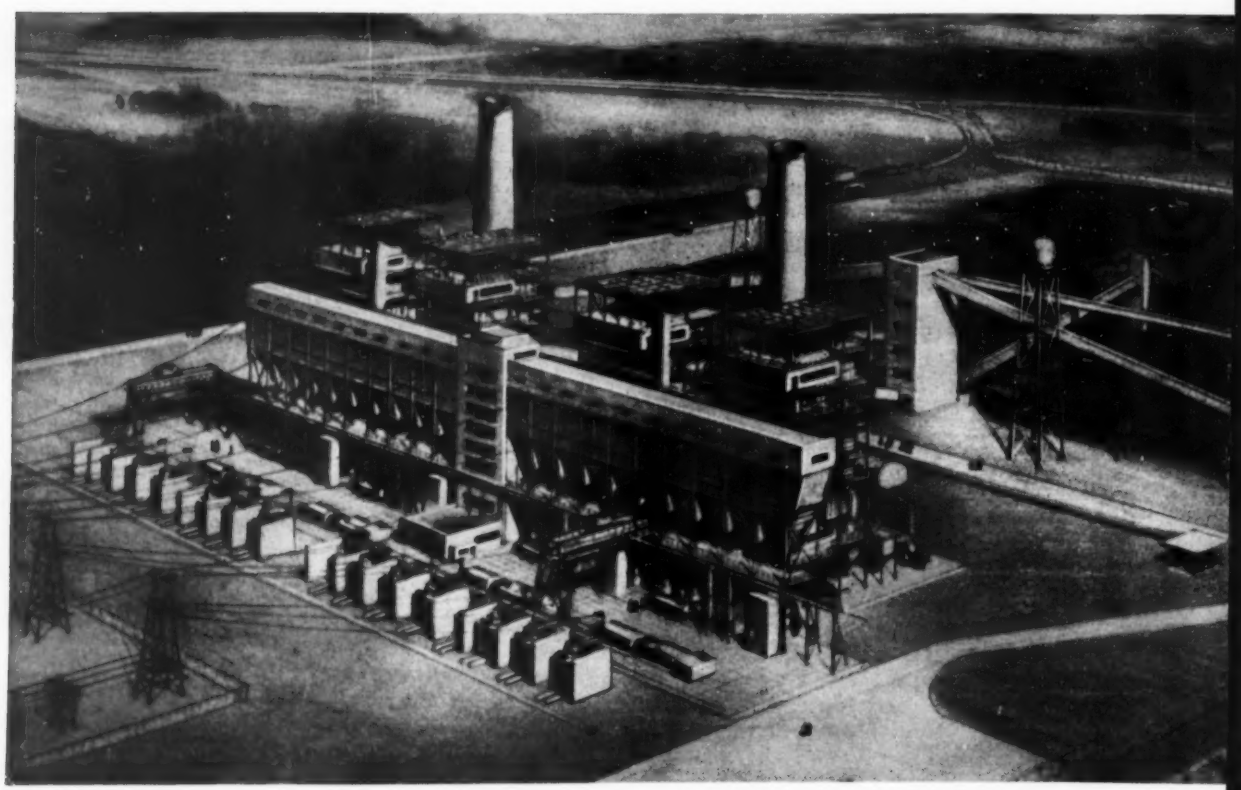

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In this great new plant, all auxiliary motors are Elliott-built. Main auxiliary drives are served by sturdy "Fabri-Steel" motors produced by Elliott's Ridgway Division, while on other auxiliaries are many of the famous Crocker-Wheeler motors, built by the Crocker-Wheeler Division of Elliott Company.

*For full details on Elliott Crocker-Wheeler and Elliott Fabri-Steel motors, contact your local Elliott representative or write Elliott Company, Jeannette, Pa.*

## ELLIOTT Company

**RIDGWAY DIVISION — CROCKER-WHEELER DIVISION**

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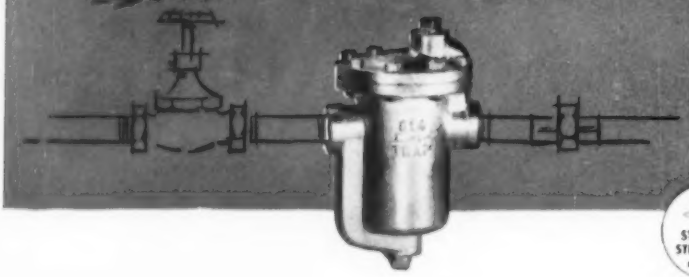
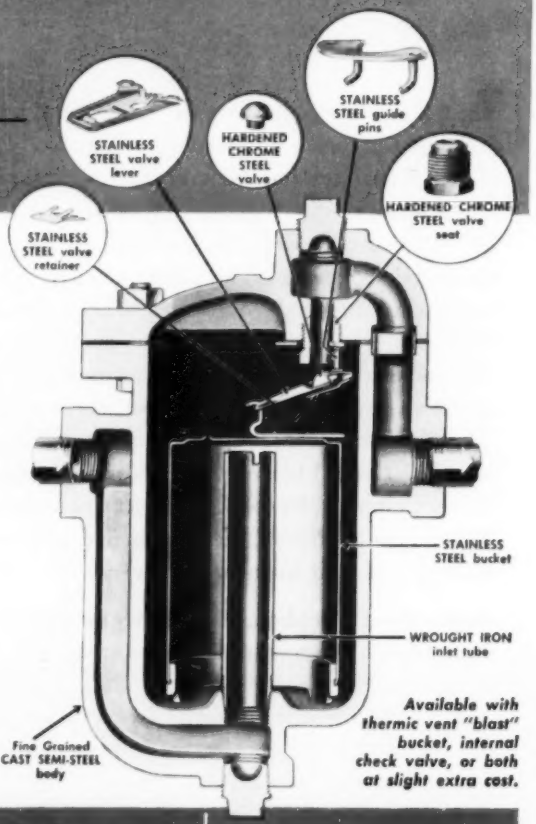
# NEW

# ARMSTRONG No. 814

## . . . a side inlet-side outlet steam trap with 1" or 1¼" pipe connections!




STAINLESS STEEL valve lever
HARDENED CHROME STEEL valve
STAINLESS STEEL guide pins
STAINLESS STEEL valve retainer
HARDENED CHROME STEEL valve seat
STAINLESS STEEL bucket
WROUGHT IRON inlet tube
Fine Grained CAST SEMI-STEEL body

*Available with thermic vent "blast" bucket, internal check valve, or both at slight extra cost.*

NOW, with the addition of the No. 814, you have a choice of five sizes of Armstrong side inlet-side outlet traps from ½" to 1¼" for use wherever horizontal and opposite pipe connections will make the simplest hookups. Bottom inlet-top outlet traps are available in the same size range, so that for the majority of all condensate loads you can use the body style that best suits the job.

Capacity of the new No. 814 is 6500 lbs./hr. at 125 psig.; height 13⅜"; face to face dimension 8"; weight 45 lbs.; price $46.00 list.

For complete data on the No. 814 and other Armstrong traps, call your Armstrong Representative or mail the coupon today.

**ARMSTRONG MACHINE WORKS**
**810 Maple St., Three Rivers, Mich.**

FIG. 1. Standard hookup for side inlet-side outlet traps.

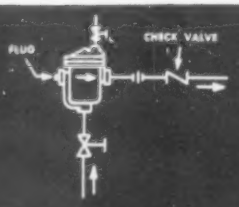



FIG. 2. Alternate hookup with inlet at bottom.

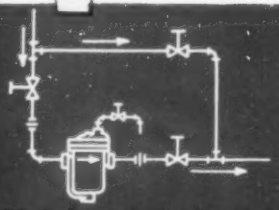


FIG. 3. Bypass hookup for side inlet-side outlet traps.

**HOW TO ORDER:**

Refer to Armstrong Catalog J, Sweets' Plant Engineering or Industrial Construction Files or Chemical Engineering Catalog. Capacities of the 814 are identical to the 214 trap listed in these Catalogs. Other data are given above. Specify trap number, pipe connections and maximum operating pressure.

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- ☐ Send complete data on No. 814 trap.
- ☐ Send Catalog J listing all Armstrong traps.
- ☐ Have Representative call.

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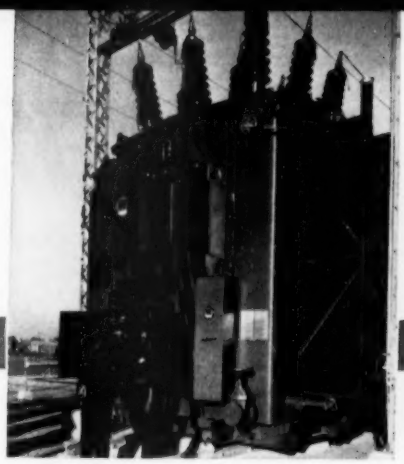

This 12,500-kva regulating unit is used on 66,000-v lines of the Southwestern Power & Light Co.

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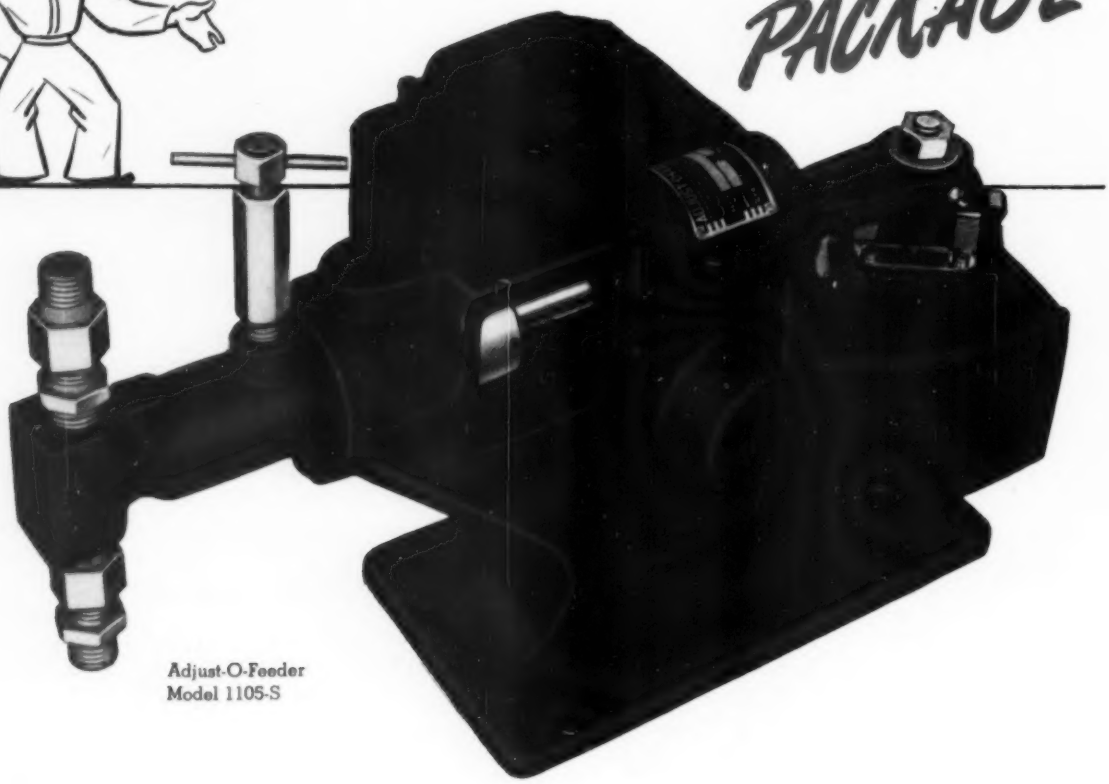
**The only magazine devoted exclusively to the job interests of power engineers**

# NEW BOILER WATER CONDITIONING PACKAGE



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*Ask for Bulletin 1105*

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# ENGINEERS' PREVIEW

APPOINTMENT of Thomas E. Bell as sales manager for the Republic Flow Meters Co., Chicago, effective April 1, has recently been announced by George S. Hendrickson, vice president. Mr. Bell joined the Republic organization in 1925 upon graduation from Georgia Tech with a B. S. degree in engineering. For the past 20 years, Mr. Bell has been manager of the Southern Territory with headquarters in Atlanta, Georgia. Thomas Waldrop has been appointed to fill the vacancy left by Mr. Bell and will become manager of the Atlanta Office.

* * *

**IT'S NOW COMBUSTION ENGINEERING, INC. The stockholders of Combustion Engineering-Superheater, Inc., at their annual meeting on April 14, so voted. It seems to be a very sensible change, because throughout all our years in the power engineering field, regardless of the official, legal registered name of the company, everybody has always called it either Combustion or Combustion Engineering in conversation, and used its formal legal name only in written material.**

**At the same time this change was voted, the directors elected Joseph W. Santry chairman of the board and he will continue as chief executive officer. Samuel C. Allen retired as chairman of the board but will continue as chairman of the executive committee. Martins H. Isenberg, executive vice president, was elected president succeeding Mr. Santry.**

* * *

YOU HAVE PROBABLY heard by this time of the plan, now well under way, to interconnect the power systems of France and England by means of a high-voltage transmission cable running under the English Channel. Since the bulk of France's power system is supplied by hydroelectric plants, while the bulk of the British system is supplied by fuel-burning plants, the two systems could balance each other quite satisfactorily.

However, here's another one to think over. Now there is talk of utilizing by-product refinery gas from Saudi Arabia and piping it some 2500 miles to England, to be used as a fuel in the steam power plants and industrial plants. Ernest H. Peabody, president and founder of Peabody Engineering Corp. and Judge William A. Kelly, a director of the corporation, are planning to spend some time in England helping to analyze and solve problems arising from a contemplated large scale industrial conversion program that would utilize this gas from Saudi Arabia, as well as oil and coal.

There are, of course, many problems to be solved in using gas instead of coal or oil for fuel in England. But we have had more experience in that field than the English and should be able to help them a great deal in working out the scheme.

If the plans go through for piping gas across the African desert, across the Red Sea, down through the Straits of Gibraltar and up through Spain, France, and across the English Channel, it will offer a world of possibilities to each of those countries' industrial programs, according to Mr. Peabody.

Considering the problems in piping gas and oil and in transmitting electricity that we have solved in this country, the above ideas do not sound impossible to us. As we all know, the impossible merely takes a little longer.

* * *

**ELECTRIC LEAGUE OF Western Pennsylvania announces that the fourth Industrial Electric Exposition is to be held at the William Penn Hotel, Pittsburgh, Pennsylvania, on October 6, 7, and 8, 1953. On display will be all types of electrical equipment, apparatus and supplies used in industry.**

* * *

BASIC CHEMICAL PLANT of the future may be modeled on the jet engine, which is in turn one of the forms of the gas turbine. That rather startling statement was recently made at an ASME meeting by Gerald Piel, Editor of *Scientific American*. Anybody visiting basic research laboratories today can make that and some other predictions with great assurance, said Mr. Piel.

Already, he said, at the laboratories where fundamental research is being conducted with the view of controlling the combustion rate and the power and thrust delivered by engines for aircraft purposes, the engineers doing this work are finding themselves completely distracted by the enormous possibilities suggested by chemical kinetics.

This is the possibility of arresting in mid-flight the transient chemical compounds that turn up at various zones in a combustion chamber — and to trap these transient compounds and get them out of the reaction and stabilize them and hold them before they disappear in the waste products of combustion.

Here we have jet streams moving at supersonic speeds, at 1500 fps, and the engineers are talking about using a reaction chamber of this kind for conducting the basic chemical reactions of our future chemical industry.

Already, said Mr. Piel, one little group has gone out from one of these jet engine laboratories to plan the extraction of acetylene from such a chamber.

All this and power too?

* * *

**IN ANOTHER HUNDRED years or so, coal will remain an important source of energy in this country but the use of oil and natural gas as energy sources will be rare. From the standpoint of conserving our present energy sources, the use of solar energy offers vast possibilities, in the opinion of Dr. R. C. Jordan, head of the Mechanical Engineering department, University of Minnesota and president of the ASRE.**

**In discussing solar energy and its engineering potentialities, at a recent meeting of the Illinois Chapter ASH&VE, Dr. Jordan used slides to show that solar energy is a tremendous source of untapped energy, enough of it being available in a relatively small portion of the Southwest part of the country to take care of the energy needs of the nation. He pointed out, however, that to date conversion efficiencies obtained have not been notable. In fact, he reported that at present there is no efficient means of utilizing solar energy as a source of power.**

**ALBERT C. PASINI, superintendent of Detroit Edison's St. Clair power plant and an expert in thermal-electric generation, flew to Italy in February to attend the dedication of the new Capuano power plant in Naples. This new 90,000-kw station is equipped with boilers and turbines purchased in the United States with funds made available under the U. S. European Recovery Program.**

**For Pasini, dedication of the new generating station has had a special significance, for in 1951 he trained the team of the Italian power company's men at the Connors Creek Station, where he was then superintendent. This training problem was eased by the fact that Pasini is the son of Italian immigrants and has a good knowledge of the language. His close contact with the trainees smoothed out communication difficulties. He looked forward to greeting the men applying the know-how gained at their Connors Creek school days. He was scheduled to remain abroad for several weeks to discuss thermal plant operation problems with men of various utility companies throughout Italy.**

* * *

POWER ENGINEERS CONCERNED with steam turbine generators of 10,000 kw rated capacity or over should know about the latest preferred standards for large 3600-rpm, 3-phase, 60-cycle, condensing steam turbine generators, prepared by the joint AIEE-ASME Committee on steam turbine generators. This is publication ASME Standard No. 100, dated January 1953 and publication AIEE Nos. 601 and 602, dated January 1953 and is effective January 15, 1953, superseding November 1950 issue. It is, of course, sponsored by AIEE and ASME and can be obtained from either of these societies at 33 W. 39th St., New York 18, New York. One of the principal changes in this specification from the previous ones is that the latest issue now includes units of 150,000 kw turbine rating.

* * *

**HERE IS AN interesting item included in the revision of the chemical engineering curriculum at Lehigh University, to become effective in the Fall semester. Among other changes and a number of new options, a new course in power plants and heat engines will be added during the senior year. This is considered necessary for a well-rounded chemical engineering training, in view of the frequency with which the chemical engineer in factory work is concerned with heat problems and electric energy problems similar to those of the power plant operator.**

* * *

IF ANY OF YOU power engineers expect to be in Europe during the latter half of this year, either on business trips or vacations or — we hope — combinations of both, you might be interested in trying to attend some of the very important scientific and technical meetings that will be held there. A list of all the international and foreign scientifical and technical meetings, from the 1st of April 1953 to the end of the year, has just been published by the National Science Foundation.

While most of the meetings are highly scientific, in the most abstruse reaches of chemistry, biology, and medicine, still there are a good many of them that might be interesting to practicing power engineers. For example, on July 27, at Stockholm, Sweden, a panel on wood chemistry will be held. On July 29, at Stockholm the 13th International Congress of Pure and Applied Chemistry will meet. From September 28 to October 3, at Turin, Italy, the 5th International Mechanical Engineering Congress will be held. And there are many others.

Probably not many engineers would be interested in such meetings as the Psychoanalytical Congress or the Symposium on Scientific Organization of Botanical Gardens, except from a hobby viewpoint. But, look at the list of places where these meetings are held — Paris, London, Rome, Stockholm, Geneva, Pisa, Oxford, Mexico City, Sao Paulo. Can't any of you think up a good excuse for a trip to one of these interesting and beautiful places? We're trying to figure out some connection between POWER ENGINEERING and the International Congress of Speleology in Paris.

Anyway, if you want full information about all these meetings and where they are, get the list from the National Science Foundation, 2144 California Street, N. W., Washington 25, D. C.

* * *

**WHO SAID THIS? "It requires no sage to predict events so strongly foreshadowed to us all; still Westward will the course of empires take its way. But the last act of the drama is yet to be unfolded; and notwithstanding the reasoning of political empires, westward, northward and southward, to me it seems that the people of America will, in some form or other, extend their dominion and their power, until they shall have brought within their mighty embrace multitudes of the islands of the Pacific, and placed the Saxon race upon the shores of Asia. . . . The Saxon and the Cossack will meet once more in strife or in friendship in another field.**

**"Will it be friendship? I fear not! The antagonist exponents of freedom and absolutism thus meet at last, and then will be fought that mighty battle on which the world will look with breathless interest; for on its issues will depend the freedom or the slavery of the world — despotism or rational liberty must be the fate of civilized man. I think I see in the distance the giants that are growing up for that fierce and final encounter. In the course of events that battle must sooner or later inevitably be fought."**

**That interesting statement was made by Commodore Oliver Hazard Perry on March 6, 1856, according to Lawrence Hafsted, Director of the Reactor Division of the AEC, in a recent speech.**

* * *

RESULTS OF ONE phase of studies to produce high Btu oil gases which can be substituted for or used as a supplement to natural gas in meeting base or peak loads are presented by the Institute of Gas Technology, Chicago, in an Interim Report, Improvement of Oil Gas Substitutability for Natural Gas by Pressure Gasification, by D. L. Nicol, J. J. Guyer, E. F. Searight and H. R. Linden.

Previous studies had shown that substitutability is improved through modification of the oil gases by scrubbing. The present work indicates further improvement is achieved if the oil gases are produced under moderately superatmospheric pressures, which results in an increase in methane and ethane contents, and a decrease in hydrogen and ethylene contents.

Research is sponsored by American Gas Association.

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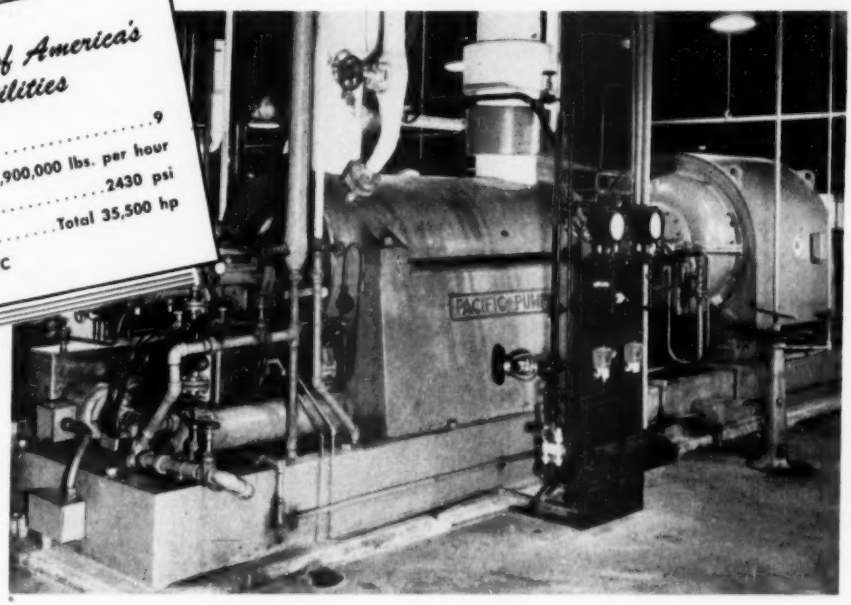


Pacific Boiler Feed Pumps are fabricated from selected materials to provide the utmost structural strength and stability – maximum resistance to corrosion-erosion and wear. Built in multi-stages for capacities to 2700 gpm; discharge pressures to 3000 psig; speeds to 5000 rpm.

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**Capacities to 500 gpm**
**Discharge Pressures to 1100 psi**
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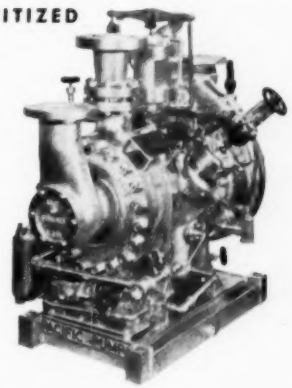

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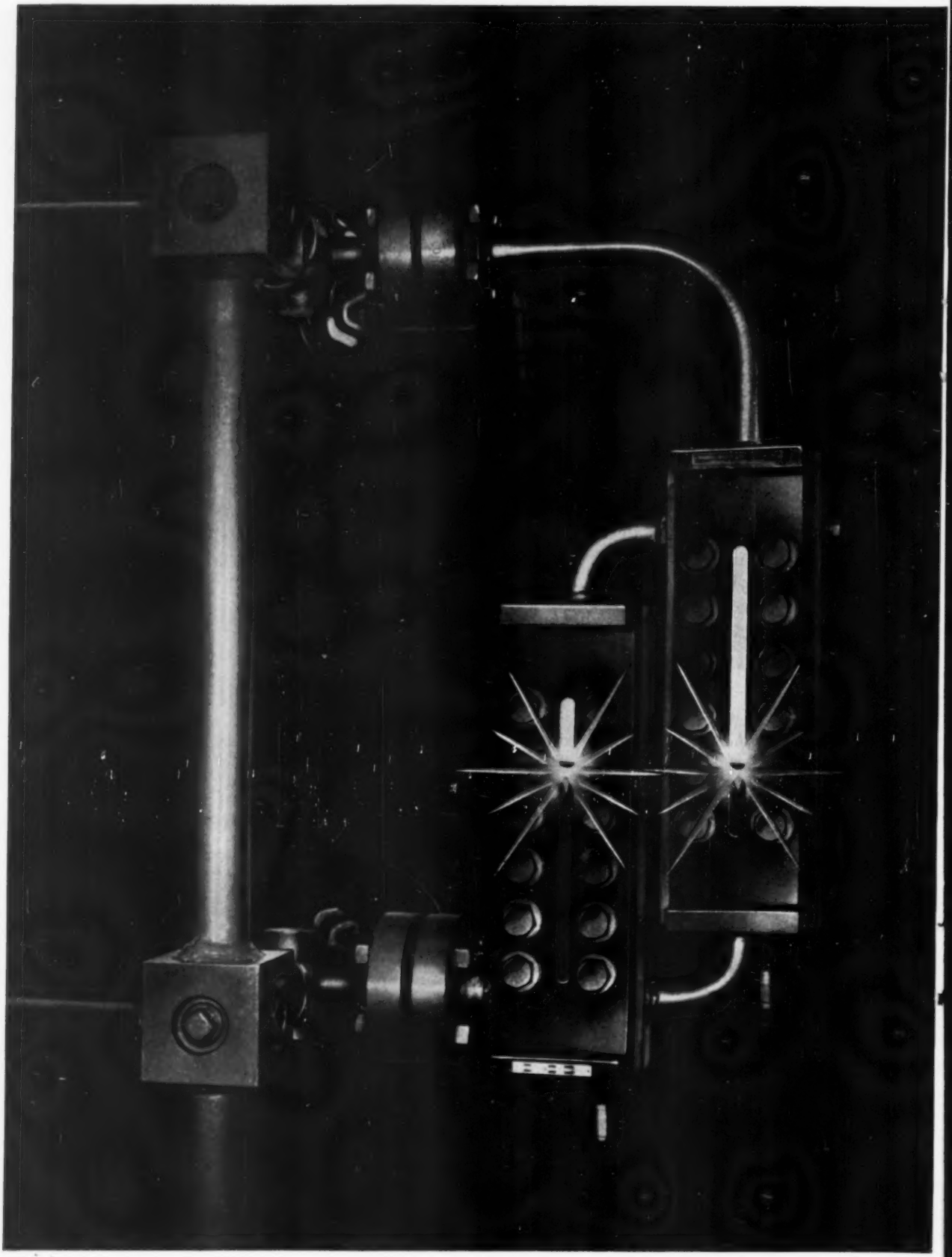


# VISIBILITY THAT SHINES LIKE A STAR

IT'S LIGHT! IT'S BRIGHT! IT'S RIGHT!

You see instantly the accurate boiler water level in your Yarway Flat Glass Gage because *the meniscus at water level stands out like a brilliant star* . . . thanks to the Yarway Type "M" Illuminator.

The Type "M" Illuminator is specially-designed to give maximum brilliance to Yarway flat glass inserts, and to spot the water level over its entire traverse. The superior penetration of its light cuts through extraneous light, dust particles in the air, and deposits on the gage glasses. Because of its brilliance it is effective over longer distances.

# LONG LIFE FOR GAGE GLASSES

The new Yarway flat glass water gage assembly was developed to meet demands for greater dependability, longer life and more accurate readings. Many hundreds of installations in high pressure plants all over the country are proving that it does all this.

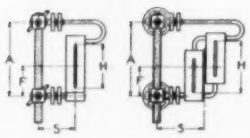
Gage glass inserts are of the Yarway pressure-sealed "floating assembly" type that distributes pressure evenly, minimizing leakage and glass breakage . . . greatly extending gage glass life.

For wide ranges, greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops. Other new features (1) Yarway Welbond gage valves, (2) short connection to drum assuring greater accuracy and eliminating a stuffing box on the lower connection, (3) upper flanged loop connection between insert and gage valve allows expansion and contraction of the various components, (4) tie-bar-type water column linking gage valve provides circulation to keep gage nearer drum temperature.

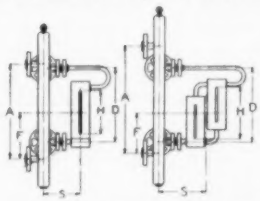
# FOR EVERY HIGH PRESSURE BOILER

There is a Yarway Water Column and Gage combination for every boiler 600 psi and over. For full descriptions write for Yarway Bulletin WG-1811.

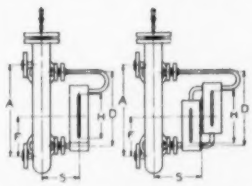
YARNALL-WARING COMPANY, 114 Mermaid Ave., Philadelphia 18, Pa.



Yarway Tie-Bar-Type Water Column with single or double inserts.



Yarway No-Alarm Water Column with single or double inserts.



Yarway 5" Hi-Lo Alarm Water Column with single or double inserts.

**YARWAY® / water columns and gages**

For more data circle 505 on Post Card

# R-S valvEvents

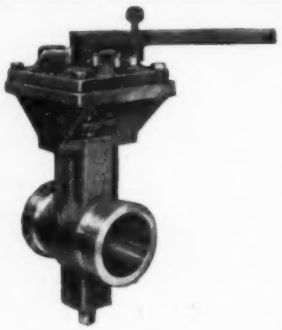
• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

*R-S Valves provide quick opening yet tight means of overflow control. Photograph courtesy William Allen Son's Company, Worcester, Mass.*

## Specify R-S VALVES

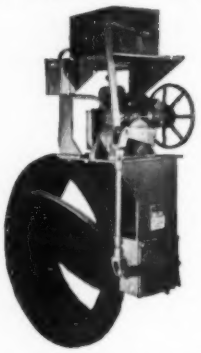
- for simplified and economical control and shut-off of volume and pressure
- with metal to metal seat including babbit or rubber seat
- for manual or any type of automatic control
- for any material that flows or is forced through a pipe
- in any material that can be cast or welded including plastics and certain alloys especially adapted to resist corrosion, erosion and temperature.
- in all sizes for all industries and processes, and in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.

Representatives are listed in telephone directories as: "R-S Products Corporation Valves".



**No. 674—Special 2½-inch stainless steel valve with 150 psi construction. Standard sanitary type threads. Heavy duty handlever assembly Type No. 681.**

**No. 848—Heavy duty valve with rubber seat for water service at high velocity. Handwheel operates valve through spur gear and pinion into a threaded reach rod (enclosed Type No. 700) in order to obtain sufficient torque to seat disc in rubber.**



**No. 847—Heavy duty valve with electric motor operator mounted directly above valve and positioned by pressure controller mounted above the motor.**

Consult your local R-S Valve Engineers, or write direct.

**R-S PRODUCTS CORPORATION • 4600 Germantown Ave., Philadelphia 44, Pa.**

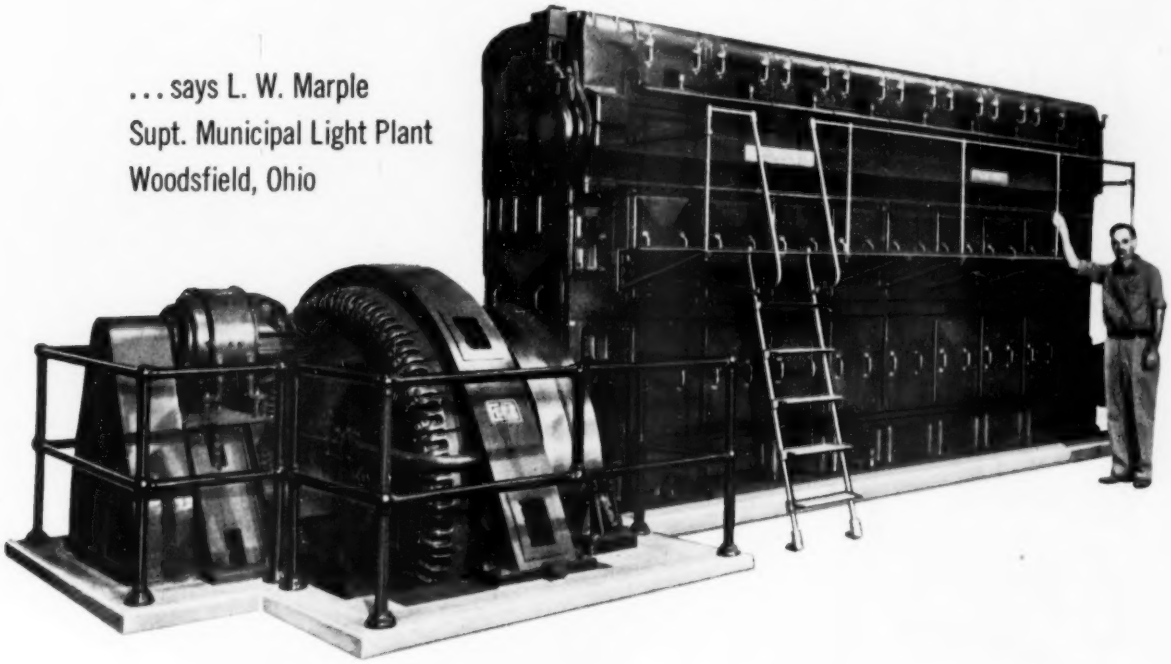
*An S. Morgan Smith Company Subsidiary*

**DISTRICT OFFICES IN PRINCIPAL CITIES**

**For more data circle 506 on Post Card**

# "No More Sticking Rings..."

... says L. W. Marple
Supt. Municipal Light Plant
Woodsfield, Ohio



● "Because of the lubricating oil we were previously using," says Mr. Marple, "sticking rings and carbon build-up were persistent problems on our three Fairbanks-Morse Model 32-E diesels.

"Three years ago, at the recommendation of one of your lubrication engineers, we switched to Sinclair GASCON® Oil D — HD.

"GASCON D — HD has cleared up our troubles... no more sticking or broken rings... no more carbon build-up, even though our load factor has increased. The result is a considerable savings in maintenance costs.

"We are also getting outstanding results with GASCON in our new 875 H.P. National Superior Dual Fuel Engine."

Perhaps a Sinclair Lubrication Engineer can solve *your* lubrication problems. Call your local Sinclair Representative or write to Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

**SINCLAIR**

**DIESEL**

**LUBRICANTS**

save wear and replacements

**For more data circle 507 on Post Card**

**ECLIPSE FUEL ENGINEERING WRITES:**

# "Heat Prover Completed a 30 Hour Burner Test In Just 6 Hours!"

## Amazing Cities Service Heat Prover Works 5 Times As Fast As Old Method... More Accurate, Too!

Robert W. Pixler, Laboratory Supervisor for Eclipse Fuel Engineering Company, Rockford, Illinois writes:

"It did not seem possible that an instrument that is so fast and direct-reading could possibly have the accuracy we demand. But, we found the Heat Prover equally exact, possibly even more exact, than standard commercial testing equipment.

"Our test work with previous instruments was a long, drawn-out affair. But with the Heat Prover, we completed what would normally have been a 30-hour test in just 6 hours!...and we doubt that our old equipment could have maintained the accuracy delivered by Cities Service Heat Prover."

**WHEREVER A FURNACE OPERATION IS INVOLVED, the Heat Prover can help increase productivity by providing:**

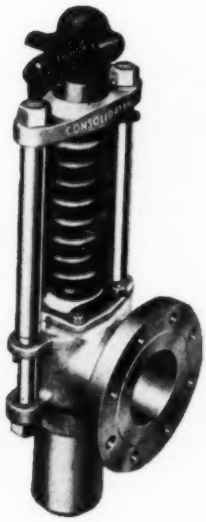
- **Rapid, continuous sampling**
- **Simultaneous reading of oxygen and combustibles**
- **Direct measurement of oxygen and combustibles**
- **Easy portability**
- **No maintenance; no re-calibration**

For details, contact nearest Cities Service office or write Cities Service Oil Company, Dept. 17F, Sixty Wall Tower, New York City 5, N. Y.

**QUALITY PETROLEUM PRODUCTS**

CITIES SERVICE

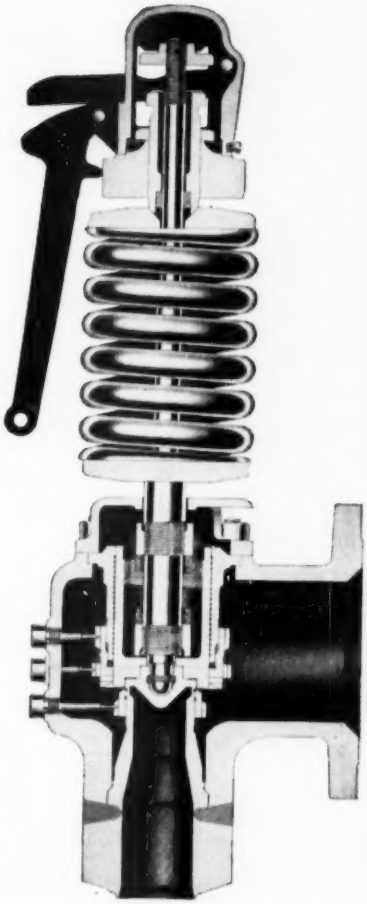
**For more data circle 508 on Post Card**



# MAXIMUM FLOW...

## CONSOLIDATED *Maxiflow* SAFETY VALVES

## Give you that—and more!



**GREATER DISCHARGE CAPACITY** that is there *when you need it* . . . tightness that you can depend on *month-after-month* . . . and other design features for high pressure, high temperature service mean one valve only — the Consolidated *Maxiflow* Safety Valve.

You can rely on the Maxiflow. Punishing laboratory tests and the toughest field services have demonstrated the functional ruggedness and dependability of the Maxiflow. Design advantages include:

**Thermodisc Seat For Permanent Tightness.** Equalizes temperature differentials when the valve reseats after blowing, minimizes thermal stresses, prevents seat distortion.

**Design And Materials Assure Retention Of Popping Point.** Special alloy steel is used to obtain stability of the spring support in the yoke rods, and a stainless steel spindle compensates thermally for any possible elongation of other parts that effect spring loading.

**Controlled Blowdown.** Simply and externally adjusted while the valve is under pressure.

**Forged Mechanical Through Bushing.** Provides constant entrance conditions for steam flow. There is no leakage due to porous castings.

Whatever size safety valve you need — 1½", 2", 2½", 3", or 4" — choose Consolidated *Maxiflow*, the safety valve that sets a new standard in protection and service. Complete data, including capacity tables, are available in Bulletin 707. Write for a copy.

## CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

**For more data circle 509 on Post Card**

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

# COPPER ALLOY BULLETIN

Bridgeport BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

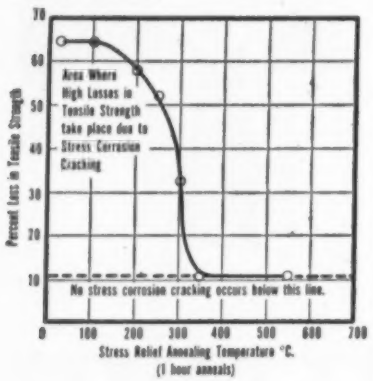
## Preventing Stress Corrosion and Season Cracking of Condenser and Heat Exchanger Tubes

### PART II

As mentioned in last month's Copper Alloy Bulletin, stress corrosion and season cracking generally result from the combined effects of the presence of ammonia in the atmosphere, the composition of the alloy and the magnitude of the stresses present in the tubing. The absence of any one of these factors prevents stress corrosion and season cracking from taking place. Consequently, the reduction or removal of stresses in the tubing is a preventive measure.

This can be effected by stress relief annealing. A temperature in the neighborhood of 200°C or higher is required for reduction or removal of such stresses. The stress relief annealing temperature varies with the alloy and extent of cold working.

Effect of Stress Relief Annealing Temperature on Stress Corrosion Cracking (Alternate Immersion in 15% normal $NH_4OH$ Solution, 50% Hard Leaded Brass Tubing).


Area Where High Losses in Tensile Strength take place due to Stress Corrosion Cracking
No stress corrosion cracking occurs below this line.
Percent Loss in Tensile Strength
Stress Relief Annealing Temperature °C.
(1 hour anneals)

It is evident from this laboratory test that relief of stress begins at temperatures above 100°C and apparently is not complete until recrystallization occurs.

In the manufacture of condenser tubes such as Admiralty, Muntz, Aluminum Brass, and Aluminum Bronze, the tubes are cold drawn to the finished size. This is followed by annealing to remove stresses and to recrystallize the metal for the formation of the grain size called for in A.S.T.M. Specification B-111-52.

Copper and Arsenical Copper tubes are supplied in any one of the following tempers:

Light Drawn Temper
Hard Drawn Temper
Hard Drawn Temper End Annealed.

90-10 Cupro Nickel tubes may be supplied in either light drawn temper or annealed temper.

Copper, Cupro Nickel and Red Brass are more resistant to stress corrosion cracking than Admiralty, Muntz, and Aluminum Brass. The relative order of merit is as follows:

Copper
70-30 Cupro Nickel
80-20 Cupro Nickel
90-10 Cupro Nickel
Red Brass
Aluminum Bronze
Admiralty
Aluminum Brass
Muntz Metal.

The annealed condenser tubes are required by the A.S.T.M. specification to stand without cracking an immersion for 30 minutes in a 1 per cent mercurous nitrate solution. However, this test is not required for copper, arsenical copper and copper-nickel tubes because they are resistant to cracking in this solution.

#### Effects of Improper Handling

The ends of tubes may be injured through excessive expansion and hardening during roller expansion into the tube sheets. Expanding into enlarged or oversized holes in the tube sheets will stretch the circumference of the tube more than normally and may result in high residual stresses at the end of the roller-expanded section.

The expanding of the tube beyond the thickness of the tube sheet may also leave the metal with high residual stresses. In most environments these stresses will be of no serious consequence, but if ammonia, mercury, or mercury salts come into contact with the stressed brass, cracking may result soon after exposure. The most common source of ammonia emanates from the decomposition of slime on the tube surface particularly during a stagnant period such as when the condenser is not in operation. Trouble from this source during equipment shutdown can be minimized by thoroughly drying out the condenser tubes by blowing warm air through the unit or chemical treatment (such as chlorination) for the removal of slime or prevention of slime.

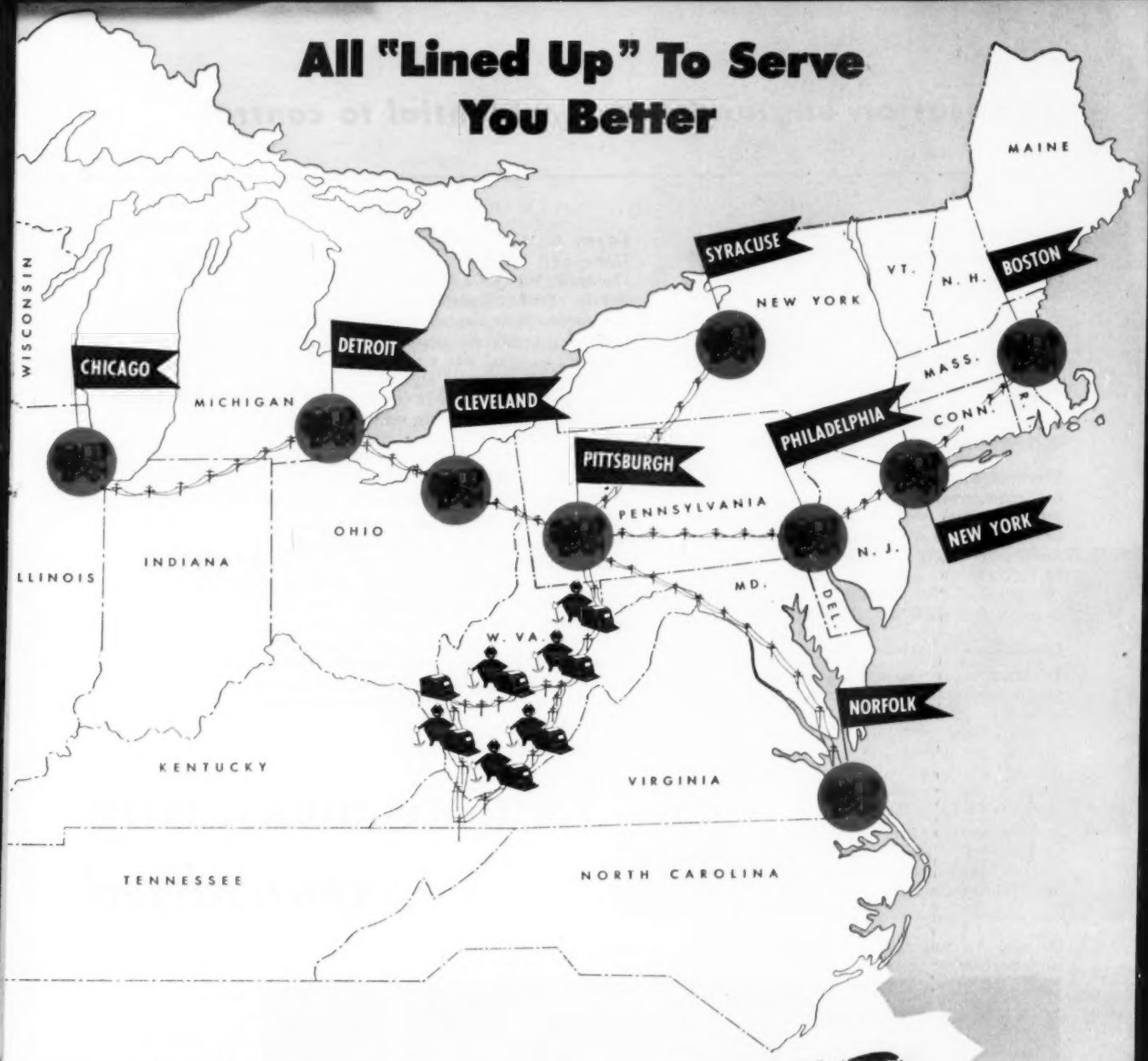
#### Effect of Liquid Metal on Stressed Tubes

Rapid intercrystalline penetration of brass and copper alloys by liquid metals such as mercury and molten solder may cause cracking. This is occasionally encountered in condenser and heat exchanger tubing. Such penetration can occur in a matter of seconds when the tube is bent or otherwise deformed or stressed before or during contact with the liquid metal. Liquid mercury sometimes finds its way into heat exchangers from mercury salts, originally present in certain crudes or from pressure measuring or control devices using mercury.

Bridgeport's Corrosion Laboratory is constantly investigating the behavior of metals and alloys under a wide range of conditions. Get in touch with the Bridgeport office nearest you for assistance in solving your condenser tube problems and meeting your special requirements. (9775)

For more data circle 510 on Post Card

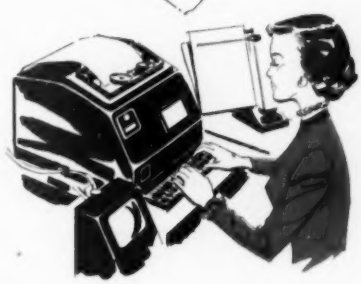
# All "Lined Up" To Serve You Better




Here's *one* of the reasons why buying Beacon coal is almost like having a mine at your back door, so far as fast, efficient service is concerned.

Most of our mines, and all of our offices, are connected into a wide-spread Teletype network. Inquiries, expediting of orders, and information on shipments are all handled as promptly and completely as a local phone call. You get your answers quickly—and more important, you get your coal when, where and as you want it.

Beacon quality coals are exactly suited to individual applications . . . and Beacon service is exactly suited to your individual needs.



EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

PITTSBURGH • BOSTON • CHICAGO • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • SYRACUSE

*For New England:* New England Coal & Coke Co. *For Export:* Castner, Curran & Bullitt, Inc.

# Application engineering . . . *essential to control*

No matter what the product, every plant uses methods, materials and equipment that present problems peculiar to its own production. Specifications . . . size of plant . . . rate of output . . . all impose further unique restrictions.

What, then, about process control instrumentation? To do its job right, it has to be designed with all those factors . . . and many others . . . in mind. And here is where Honeywell Application Engineering steps in.

First comes a thorough investigation of control requirements. A Honeywell engineering representative, well versed in instrumentation techniques sits down with process engineers, production men, and instrument technicians . . . discusses details of the specific process. Then he puts the problem up to Honeywell's staff of application engineers.

**Specialists for Each Industry**

In this group are men who are expert in each specific industry. One group, for example, specializes in instrumentation for the metalworking industry . . . another for chemical . . . another for petroleum . . . until the whole gamut of modern manufacturing is represented. Each man has been trained, by education and first-hand experience, in the techniques of processing and process control in the area of his interest. Each is a living part of the industry he serves. And he knows why and where every process "is different."

**Covers All Aspects of Control**

Honeywell application engineering covers the entire control installation. It works out details of what instrument to use for each measurement or control function . . . what type of primary element . . . what control system . . . what size and style of valve. It provides all essential signals, safety interlocks, and accessories. It combines all these elements into a complete unit, arranged for peak production efficiency . . . greatest convenience of the operator, and for maximum ease of service . . . custom-fitted to the individual needs of the process to be controlled.

**Saves Time . . . Produces Top Performance**

This Honeywell service gives specialized consultation on complex control problems that would otherwise require the attention of experts in the individual plant. But most important, it assures a control system that will produce the superior performance that Honeywell instruments are capable of giving . . . and which will help to obtain the most production and best quality from the process which it serves.

# Remote measuring *centralized*

**SOUND PLANNING,** *based on specialized engineering experience, forms the basis of Honeywell Application Engineering. Here a round-table discussion between customer and Honeywell technicians irons out the initial control requirements for a process.*

H HONEYWELL

WHEREVER you need to bring measurements of flow, liquid level and pressure from out in the plant to a central control room, you'll find Brown remote measuring systems provide the performance you need. Utilizing pneumatic transmission, these systems consist of an appropriate transmitter and sensing element at the point of measurement—connected by small-diameter tubing to recording and controlling instruments on the main or auxiliary control boards.

**They're accurate:** operate over distances of several hundred feet with full responsiveness. Transmitter and receiver are precision-matched in design.

**They're dependable:** rugged design keeps calibration constant, from detection to final measurement. Simple construction minimizes maintenance.

Brown pneumatic transmission systems are supplied in a wide choice of ranges for power plant service.

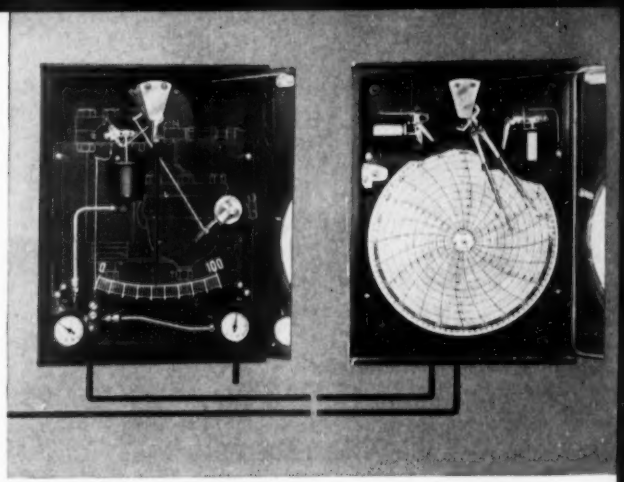
# systems for *plant control*

Electric systems are also available for these same variables. Your local Honeywell engineering representative will welcome the opportunity to discuss your own plant's applications . . . and he's as near as your phone.

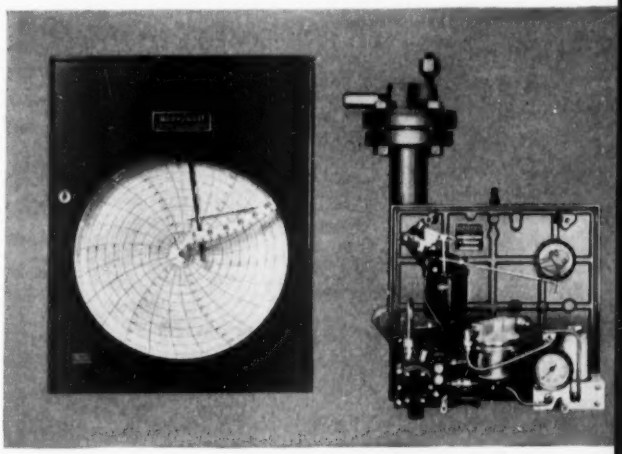
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4587 Wayne Ave., Philadelphia 44, Pa. Sales and service offices in more than 90 principal cities of the United States and Canada.

● **REFERENCE DATA:** Write for Catalog 90-2, "Supervisory Instruments for Power Generation," and for Data Sheet No. 9.1-4.

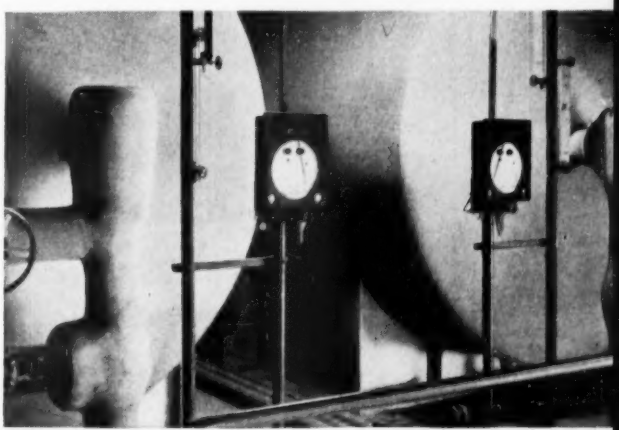
MINNEAPOLIS
**Honeywell**
BROWN INSTRUMENTS
*First in Controls*



**REMOTE PRESSURE MEASUREMENT:** *Brown systems cover the range from super heat pressures to condenser vacuum. Only low-pressure instrument air goes to the control board. Dangers of high-pressure piping are eliminated . . . panel costs are reduced.*

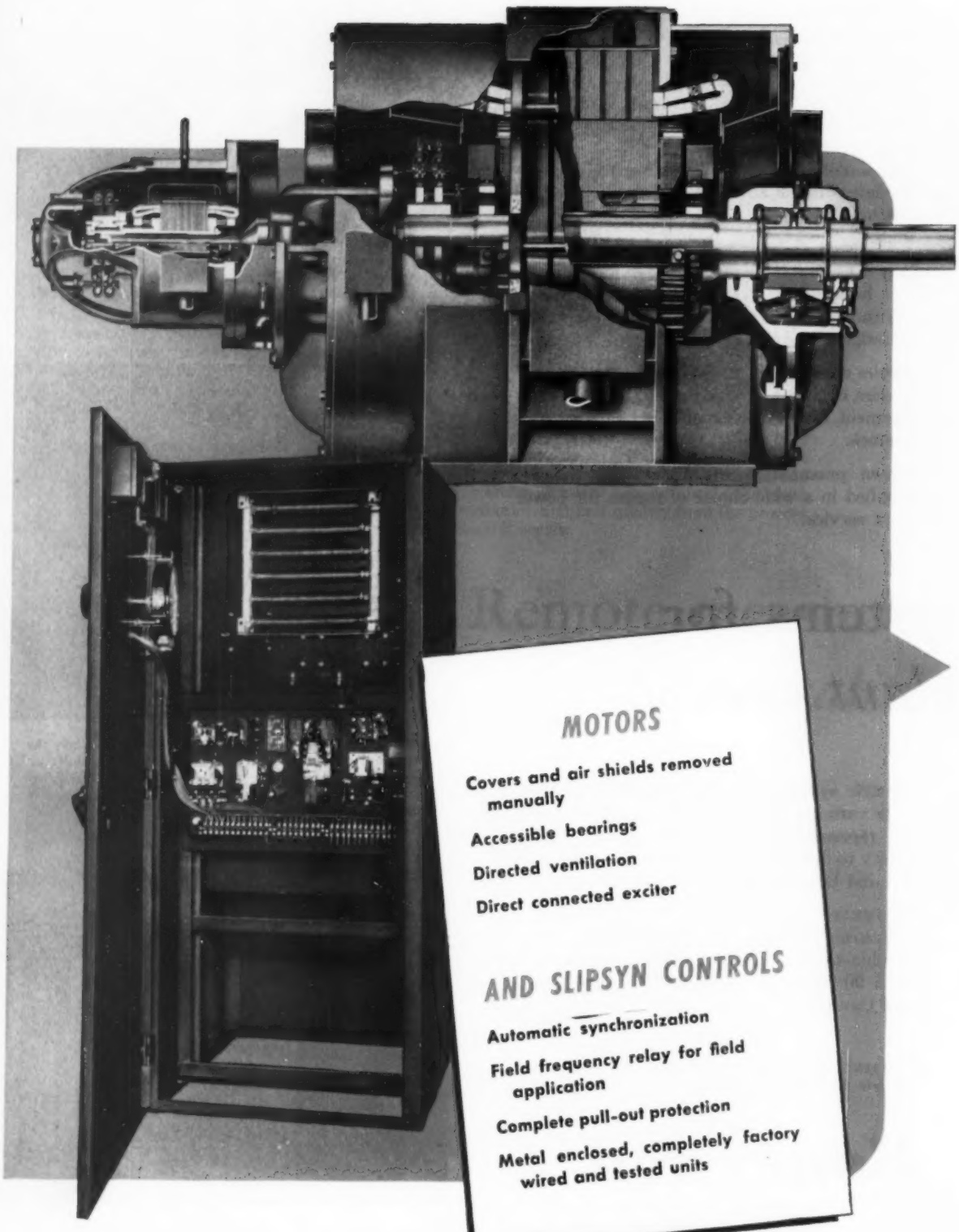


**REMOTE FLOW MEASUREMENT:** *systems can be either the square root type (electric or pneumatic transmission) or evenly graduated (electric transmission). The latter is ideal for flow cost accounting . . . has a linear scale that provides full readability at all flow rates.*



**REMOTE LIQUID LEVEL MEASUREMENT:** *keep operators informed of level in condensate tanks, hot wells, boiler drums and other remote locations. Systems are supplied for open tanks, closed pressure vessels, corrosive liquids, and liquids containing suspended solids.*

For more data circle 513 on Post Card



## MOTORS

Covers and air shields removed manually

Accessible bearings

Directed ventilation

Direct connected exciter

## AND SLIPSYN CONTROLS

Automatic synchronization

Field frequency relay for field application

Complete pull-out protection

Metal enclosed, completely factory wired and tested units

# MORE POWER PER DOLLAR

## *with Westinghouse matched synchronous Motors and Controls*

You can improve your power factor and save money on power bills with Westinghouse synchronous motors. You can save more by matching the control to the motor. That way you get a completely co-ordinated system that makes sure you get the full savings available.

**HIGH MOTOR EFFICIENCY** is inherent in synchronous motor design. Losses are lower than in induction motors. In many cases, the first cost is less. Considering first cost, low maintenance expense and improvement of power factor, the synchronous motor supplies more power per dollar for many types of drives than any other motor.

**REDUCED MAINTENANCE COSTS** are the result of exclusive inspection and servicing features. Readily accessible split-sleeve bearings can be removed by hand. There's no top half of bearing bracket to remove. Brushes are readily available through the front bracket for both inspection and maintenance.

**CONTROL IMPROVES PERFORMANCE** Getting the motor started right every time . . . providing complete protection at all times are the basic functions of the Slipsyn motor control. Heart of the system is the ASR polarized slip frequency relay. It not only applies the field at the proper speed, but also at favorable rotor position for best performance. Welded all-steel cabinets with sectionalized compartments protect personnel. All live parts are completely enclosed. Attractive cabinet blends with modern plant equipment.

**MORE DATA?** Get in touch with your local Westinghouse representative for complete details. Ask for copies of B-4379 "Slipsyn Control", and DB-3200. Or write direct to Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

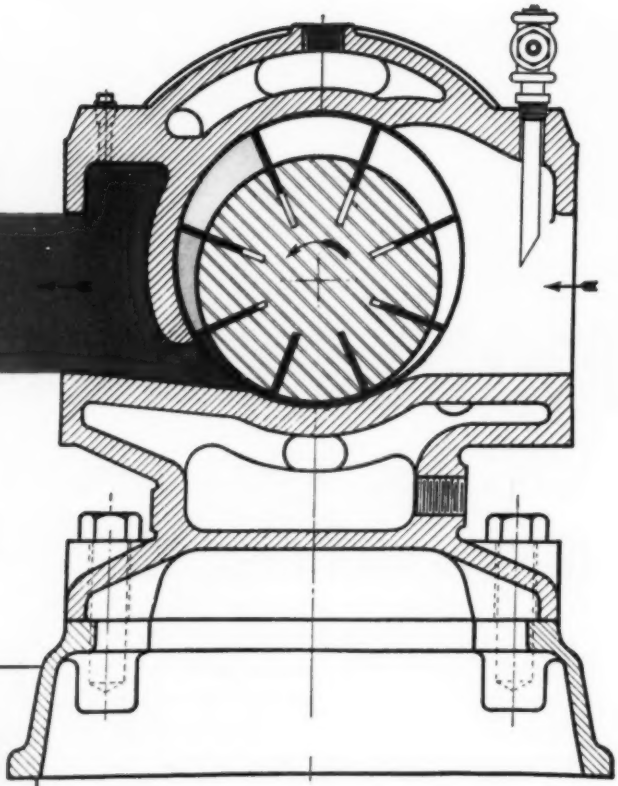
J-10352-A

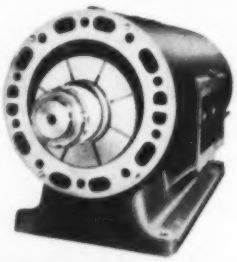
YOU CAN BE SURE...IF IT'S

Westinghouse

For more data circle 514 on Post Card

# putting the SQUEEZE on compression costs





Check your needs for • • • • *Engine Starting Air* • *Pneumatic Power*
*Pneumatic Controls*
*Refrigerant Compression* • *General Plant Air*
*Instrument Air* • *Air Lifts*

When you consider all the many uses you have for compressors—consider the best way to get compression with dependability, and minimum cost and attention.

Fuller Rotary Compressors have so many inherent advantages that they warrant your closest examination. Free from reciprocating parts, with no valves to leak or seats to grind, no unbalanced forces to set up vibration. Fuller Rotary Compressors assure low-cost, smooth-flow operation during their long life.

Check your own compressed-air needs and send this check list to Fuller. A Fuller engineer will give you the *right* recommendation to save you money. Write now to Fuller Company, Catasauqua, Penna.

**Fuller** **Pioneers of high-efficiency vane-type rotary compressors**

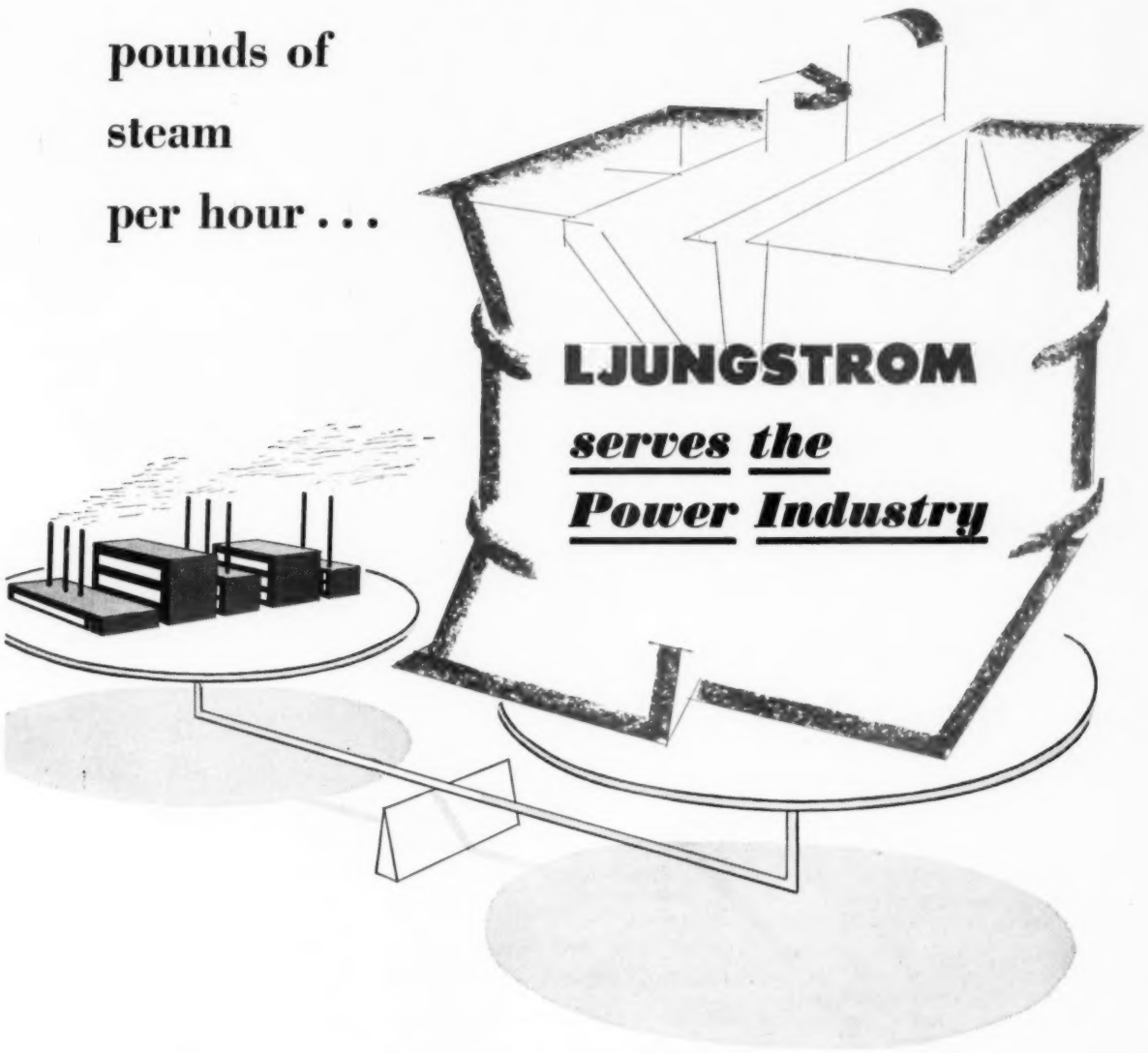
**FULLER COMPANY**
**Catasauqua, Pa.**
*Branch Offices: Chicago • San Francisco • Los Angeles • Seattle • Birmingham*

C-235
2078

**For more data circle 515 on Post Card**

# 347,000,000

## pounds of steam per hour . . .




In the post-war rush to expand power generating facilities, utilities have not lost sight of the need for *operating economy*. Increasingly over these years, the fuel-saving, performance-improving potentials of the Ljungstrom Air Preheater have been realized – until today, nearly two out of every three power boilers are ordered with the specification "Ljungstom Air Preheater."

Since 1946 alone, in fact, more than 347,000,000 pounds per hour of steam capacity – installed or on order – have been designed for Ljungstrom.

This record speaks for itself. It proves that the Ljungstrom Air Preheater

**The AIR PREHEATER CORPORATION**

**60 East 42nd Street, New York 17, N. Y.**

**For more data circle 516 on Post Card**

# Wickes steam generators help refineries operate efficiently year after year

147

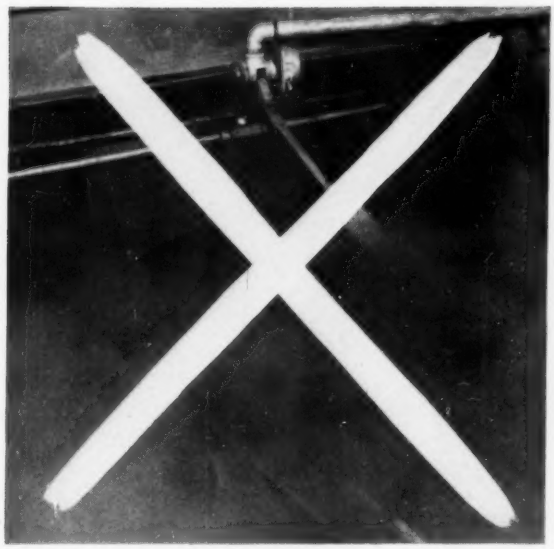
Year after year, Wickes Steam Generators have been helping the oil processing industry keep their operations efficient and their maintenance and operating costs low. In many of America's largest refineries and natural gasoline plants, Wickes boilers have been on the job almost constantly for ten, twenty or even thirty years and are still operating at a high degree of efficiency. They can do the same in your plant. Wickes can fill your requirements for any type of multiple drum boiler up to 250,000 lbs. steam per hour at 1000 psi., adaptable to any standard method of firing. Units capable of steam production up to 35,000 lbs. per hour at 1000 psi. can be shop-assembled for immediate installation. Consult your nearest Wickes representative or write us today for descriptive literature and complete information.

**Wickes**

**THE WICKES BOILER CO., SAGINAW, MICHIGAN** RECOGNIZED QUALITY SINCE 1854
**DIVISION OF THE WICKES CORPORATION**

**SALES OFFICES:** Albuquerque, N. M. • Atlanta • Boston • Buffalo • Charlotte, N. C. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Greensboro, N. C. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Orangeburgh, S. C. • Pittsburgh • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tampa, Fla. • Tulsa • Washington, D. C.

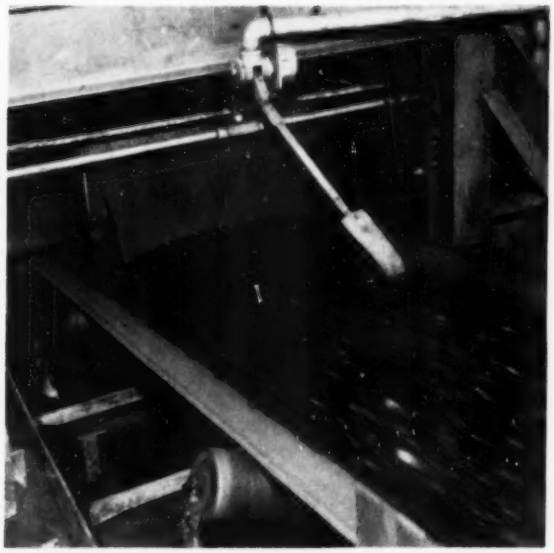
**For more data circle 517 on Post Card**



**BEFORE**—View of Coal Chute discharge onto conveyor belt at a New Jersey generating station without J-M system turned on.

# STOP COAL DUST

## in your operation at 1/10 the usual cost!



**AFTER**—Same view as above but with J-M dust control system in operation.

Here's improved appearance for your plant . . . better health for your employees . . . easier handling of your coal supply. A Johnson-March system can control or eliminate coal dust wherever it occurs in your operation *. . . at a cost only 1/10 that of most other dust control systems!*

A Johnson-March system can be installed right at car dumpers, hoppers, crushers, belt galleries or coal piles. Nothing to interfere with normal operations. So amazingly simple the maintenance cost is next to nothing.

Johnson-March systems are installed in many plants to improve the effectiveness of existing mechanical dust collection systems. If you now have no control over coal dust . . . or even if you have a mechanical dust collection system in your plant . . . it will pay you to consider the *low-cost* advantages of a Johnson-March system.

For more information on how a low-cost Johnson-March system can help solve *your* coal dust problems, send NOW for this FREE ILLUSTRATED BROCHURE.

**THE JOHNSON-MARCH CORP.** PE-6
**1724 Chestnut St., Philadelphia 3, Pa.**

With no obligation, I want to know the facts about stopping coal dust with a low-cost Johnson-March system. Please send me the FREE ILLUSTRATED BROCHURE.

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ADDRESS .....

CITY ..... STATE .....

# Johnson March

*Specialists in Dust Control*

**1724 CHESTNUT ST.** **Philadelphia 3, Pa.**

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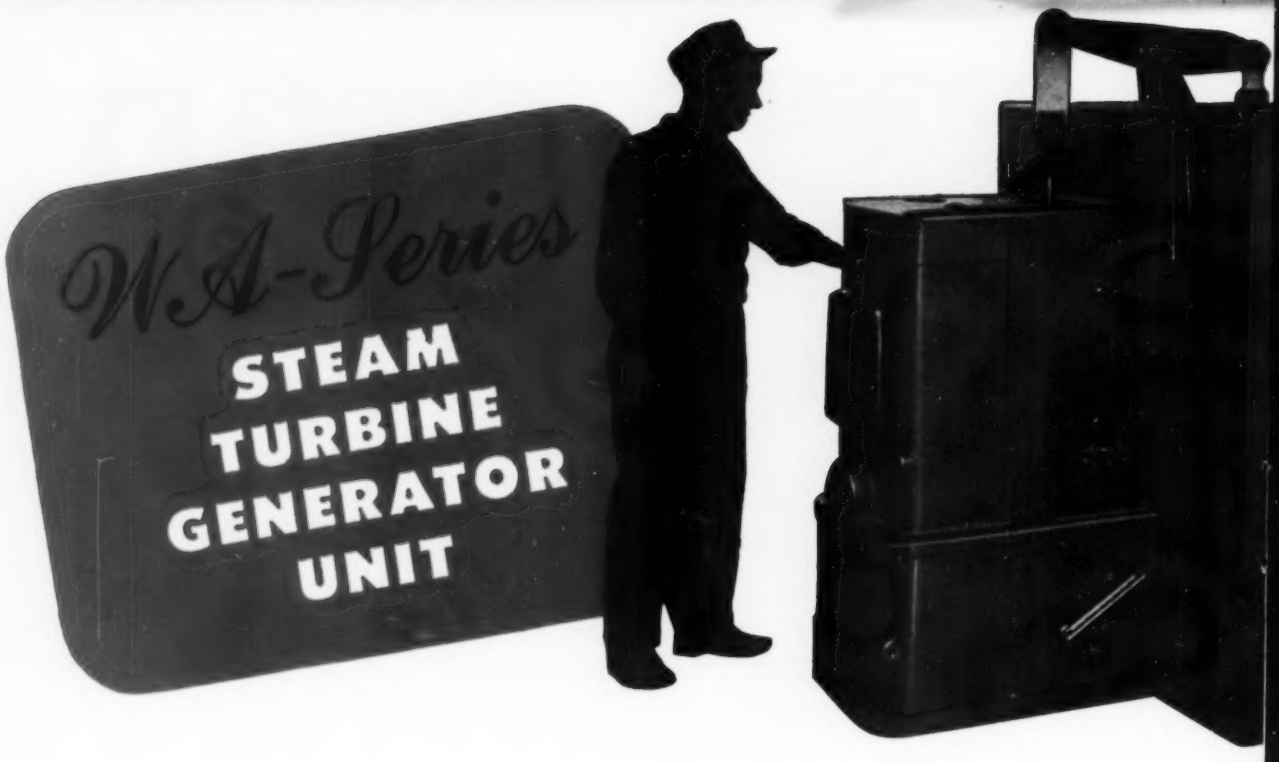


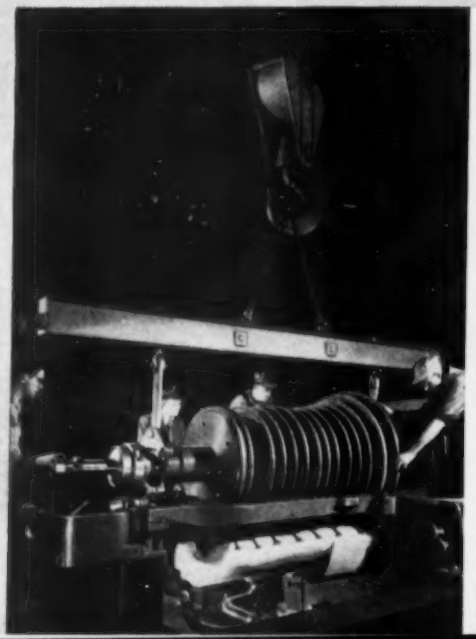

# From Shop

## HERE'S HOW Allis-Chalmers Builds the Generator Unit that's Easy to Install, Low in Foundation Cost

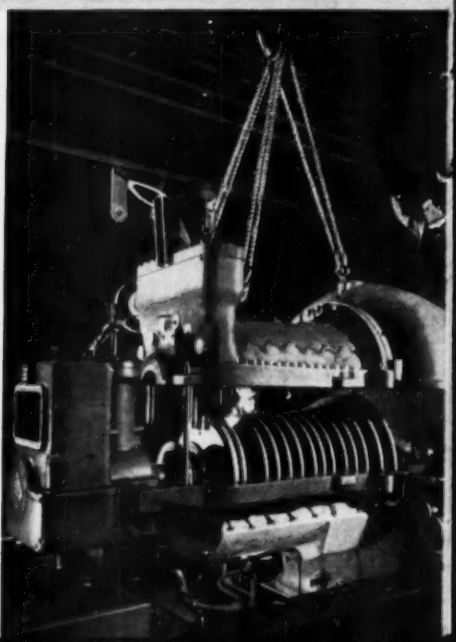
MODERN Allis-Chalmers WA-Series steam turbine generating units are factory tested and shipped with rotors locked in place to save you installation time. Oil piping and generator air coolers are both above the floor line to reduce your foundation costs.

WA-Series units are built in ratings from 2000 to 7500 kw for either condensing or non-condensing operation. For your copy of Bulletin 03B7654, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3910

**1** Precision balanced turbine rotor assembly being lowered into casing. All wheels have durable chrome alloy steel buckets.



**2** Upper half casing of this compact impulse steam turbine is next added in the process of assembling the WA-Series unit.

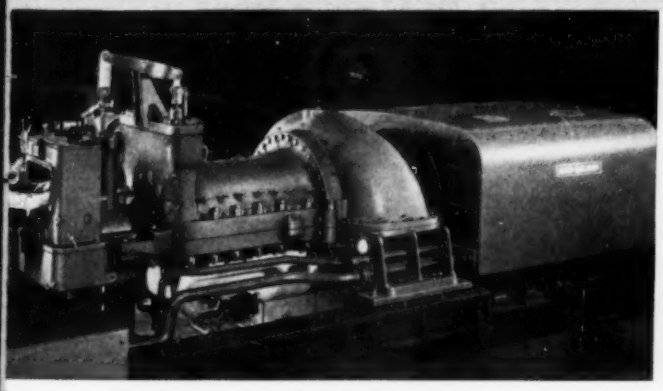


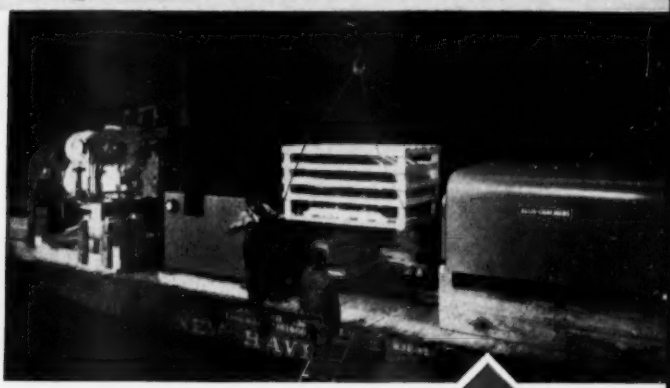
Installed and running...the WA-Series unit 3000 kw, 3600 rpm, 400 psig, 750 F, 2 in. Hg abs.

# to Shipment!

**3** Assembled 3-bearing unit — complete with housing type air cooled generator — ready for factory testing. Both oil piping and generator air coolers are above the floor line.

**4** Entire WA-Series 3000-kw unit—pre-tested and insulated—being loaded on **one** flatcar for unit shipment. Both turbine and generator are shipped with their **rotors securely locked in place.**





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ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT •

# POWER ENGINEERS!

Here's SK's Annual Bibliography of Available Technical Literature on Standard and Highly Specialized Equipment. Please Indicate Bulletins Desired. Sign Name. Return Coupon To Address Below.

**LIFTING LIQUIDS, Jet Apparatus For**

*Steam Jet Syphons, Bulletin 2-A (immediately available)* ☐

*Water Jet Eductors, Agitators, and Mixers, Bulletin 2-M (immediately available)* ☐

**HEATING LIQUIDS, Jet Apparatus For**

*Steam Jet Tank and Pipeline Heaters, Bulletin 3-A (immediately available).* ☐

**MOVING AIR AND GASES, Jet Apparatus For**

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*Barometric Multi-Jet, Spray, and Counter Current Condensers, Bulletin 5-AA (immediately available)* ☐

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*Everdur Valves and Fittings, Bulletin 7-E (immediately available)* ☐

**STRAINING LIQUIDS AND GASES, Strainers For**

*Oil Separators and Tangential Steam Separators, Bulletin 9-P (immediately available)* ☐

*Strainers, Steam, Water and Oil, Feed Water Filters, Bulletin 9-S (immediately available)* ☐

**HEAT TRANSMISSION, Apparatus For**

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*Radiafin Tubes, Bulletin 11-S (immediately available)* ☐

*Radiafin Tubes for Heating, Bulletin 11-SA (immediately available)* ☐

*"K" Type Coolers, Bulletin 12-C, Supplement OC (immediately available)* ☐

*Air Heaters, Inter and After Coolers, Air Coolers, Bulletin 12-G (immediately available)* ☐

*Heat Exchangers and Condensers, Tubular, Bulletin 12-H (immediately available)* ☐

**OIL BURNING EQUIPMENT**

*Mechanical Oil Burning Systems, Pumping, Heating and Straining Units, Bulletin 16-A (immediately available).* ☐

*Steam and Air Actuated Oil Burners, Bulletin 16-G (immediately available).* ☐

**PUMPING OIL AND OTHER LIQUIDS**

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**INDICATING, CONTROLLING, RECORDING THE FLOW OF ALL FLUIDS, Instruments For**

*Rotameter Consolidated Bulletin, Bulletin 18-RA (immediately available)* ☐

*Universal Rotameters (Glass Tube), Bulletin 18-RB (immediately available).* ☐

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**VALVES**

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*The SK Engineering News is also published quarterly in magazine form. It describes new SK equipment and design modifications, features application information specifically selected to point out product features and advantages and to provide ideas for other uses. To get your name on the mailing list, check* ☐

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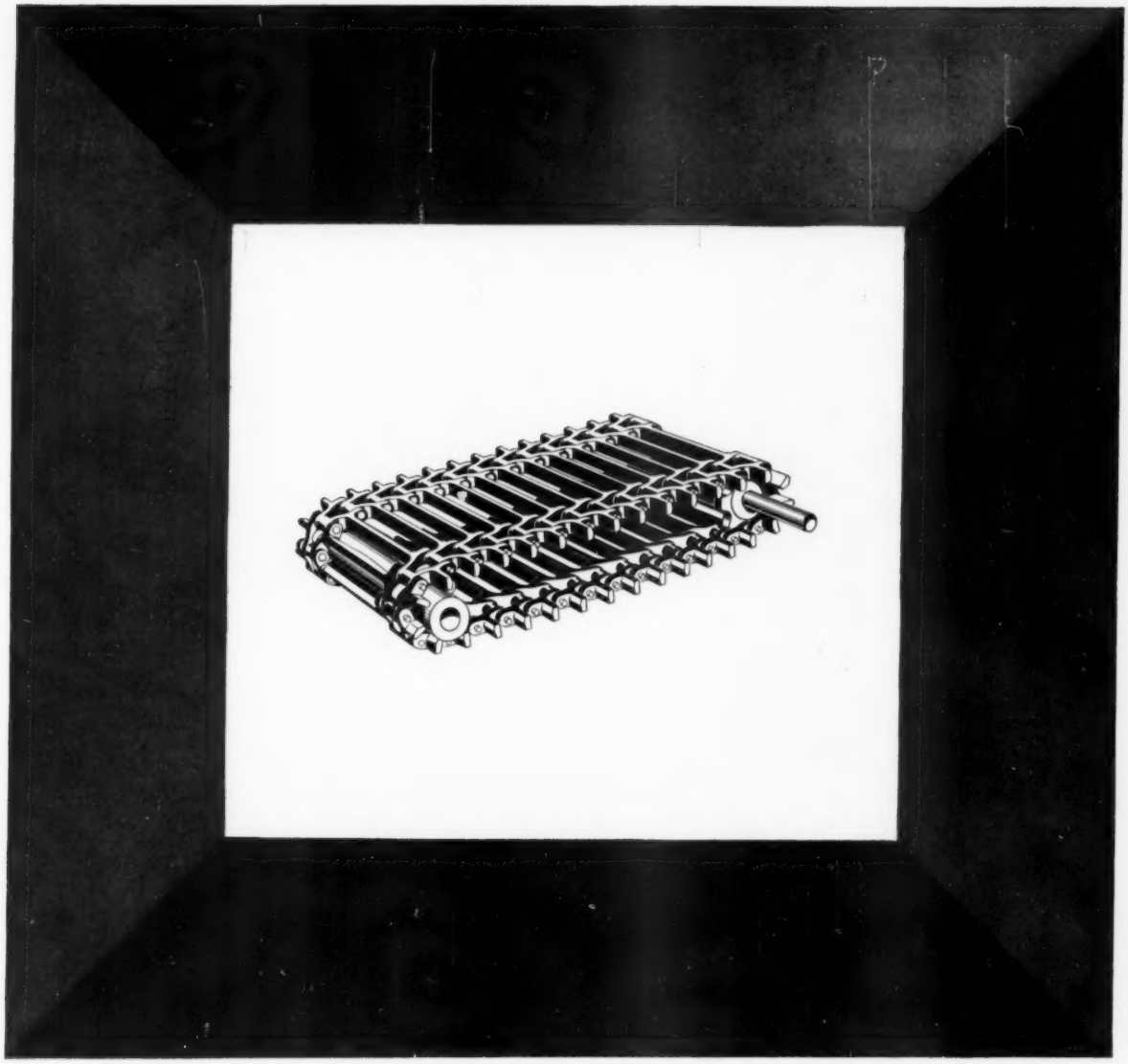

## The secret of no-clog feed for Perfect Spread

PERFECT SPREAD is the only STOKER available today that never clogs... not even on wet coal! And the secret of this remarkable efficiency is the exclusive American Engineering traveling conveyor feeder, pictured above, which employs a high traction principle and assures true, *continuous* feeding throughout its operating range of 50 to 7500 lbs. of coal per hour.

But in addition to no-clog feed, Perfect Spread Stoker gives you every other important feature... the special high-capacity spiral overthrow rotor which spreads coal over the whole grate so perfectly that it furnishes the stoker's name... the engineered cinder return and overfire air system that yield comparable results with both low and high ash coals.

Perfect Spread Stokers are made in a wide choice of sizes, capacities and grate types. Whether you are considering a new unit or restokering an old one, talk things over with your AE representative. It may lead to most steam at least cost.

AE

**AMERICAN ENGINEERING**

**COMPANY**

**2408 ARAMINGO AVE., PHILADELPHIA 25, PA.**

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**AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.**

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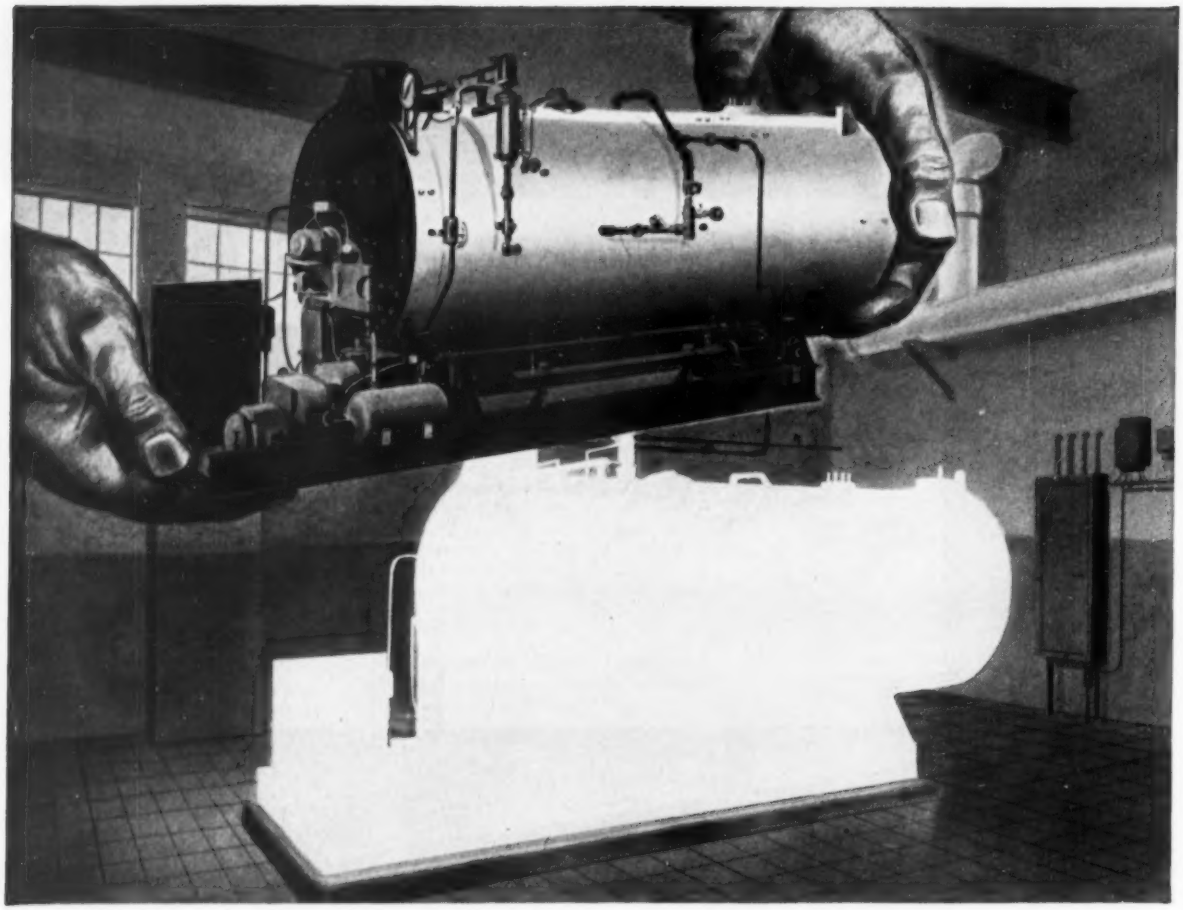
# Here's why you get more...when you buy a Cleaver-Brooks Self-Contained Boiler



## ...only Cleaver-Brooks can offer you the experience gained from more than 20 years of pioneering . . . and more than 12,000 individual "packaged" boiler installations

CLEAVER-BROOKS pioneering has been largely responsible for simplifying boiler buying . . . lowering costs of installation . . . delivering 80% guaranteed steam efficiency from every fuel dollar.

Boilers can be shipped as completely assembled and tested self-contained units, with auxiliaries as required. Installation involves minimum of time, construction and space. Usually connections only to steam, fuel, water lines and electrical service are needed. No special foundations are required. A short vent takes care of exhaust gases. Frequently, boilers are ready for use in a matter of *hours*, depending on availability of service lines.

Cleaver-Brooks, originators of the self-contained boiler, offers wider experience that counts in another important way. Qualified engineers help you plan steam plants tailored *exactly* for your needs. Carefully analyzed are loads, space and equipment arrangement. This not only helps you solve present steam needs, but adds flexibility for future expansion as well.

This application engineering, plus basically sound design and construction is your assurance of a full return from your boiler investment. When you specify a self-contained boiler — make sure it's a Cleaver-Brooks.

*Send for Catalog AD-100 for full details on Cleaver-Brooks boilers. Available for oil, gas and combination oil/gas firing. Sizes 15 to 500 hp, 15 to 250 psi — for heating and processing.*

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**ORIGINATORS OF THE SELF-CONTAINED BOILER**
Steam Boilers • Oil and Bitumin Tank Car Heaters • Distillation Equipment
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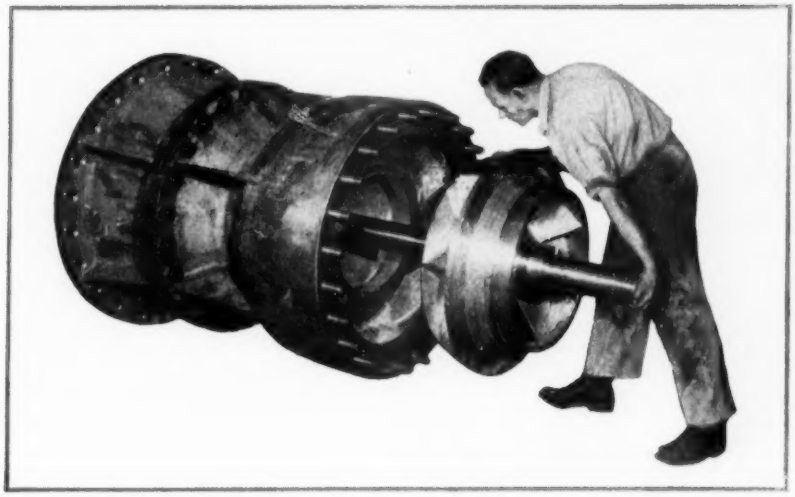
# When Erosion, Wear, Fatigue or Corrosion is a problem —try **Monel!**



Let's take a look at a spot where Monel really has a tough job — to handle corrosive salt water!

This vertical salt water pump, and five others like it, pump a total of 144,000 gallons of salt water a minute. The water is used as cooling water in high temperature processing equipment. The pumps were made by PACIFIC PUMPS, INC., Huntington Park, Calif.

If you examined the metal used in one of these pumps, you'd find nearly a ton of corrosion-resisting Monel. Monel is used for the pump shaft and keys where its high strength and fatigue resistance insures a long and trouble-free life. You'll also find Monel discharge elbows, column tubes, oil tube and box, as well as bolts, studs and nuts. Monel-Clad Steel is used for flanges, column pipes and discharges. In fact, practically all surfaces contacting the corrosive salt waters are Monel!

For an interesting booklet on how Monel fights corrosion, write for your copy of "How to Get Longer Service From Your Pumps."

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill. The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

INCO

## Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL
INCONEL® • INCONEL "X"® • INCONEL "W"®
INCOLOY® • NIMONICS® • NICKEL
LOW CARBON NICKEL • DURANICKEL®

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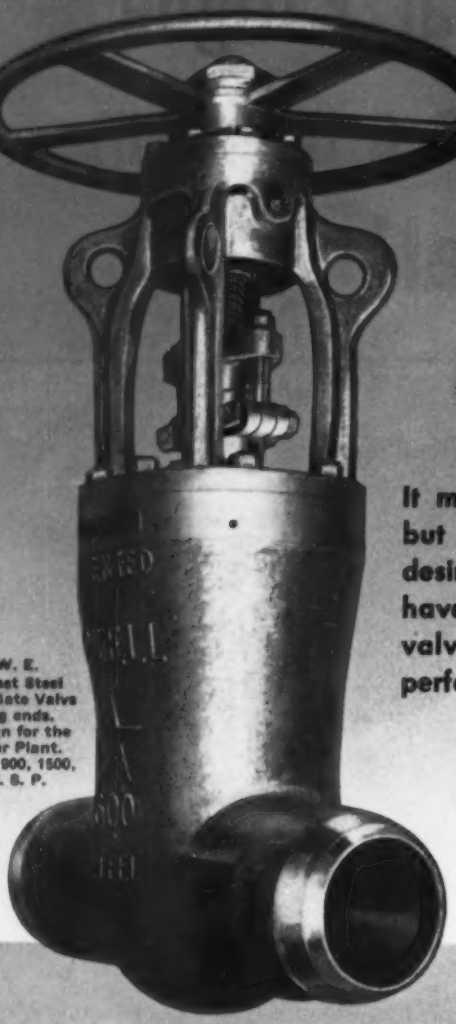
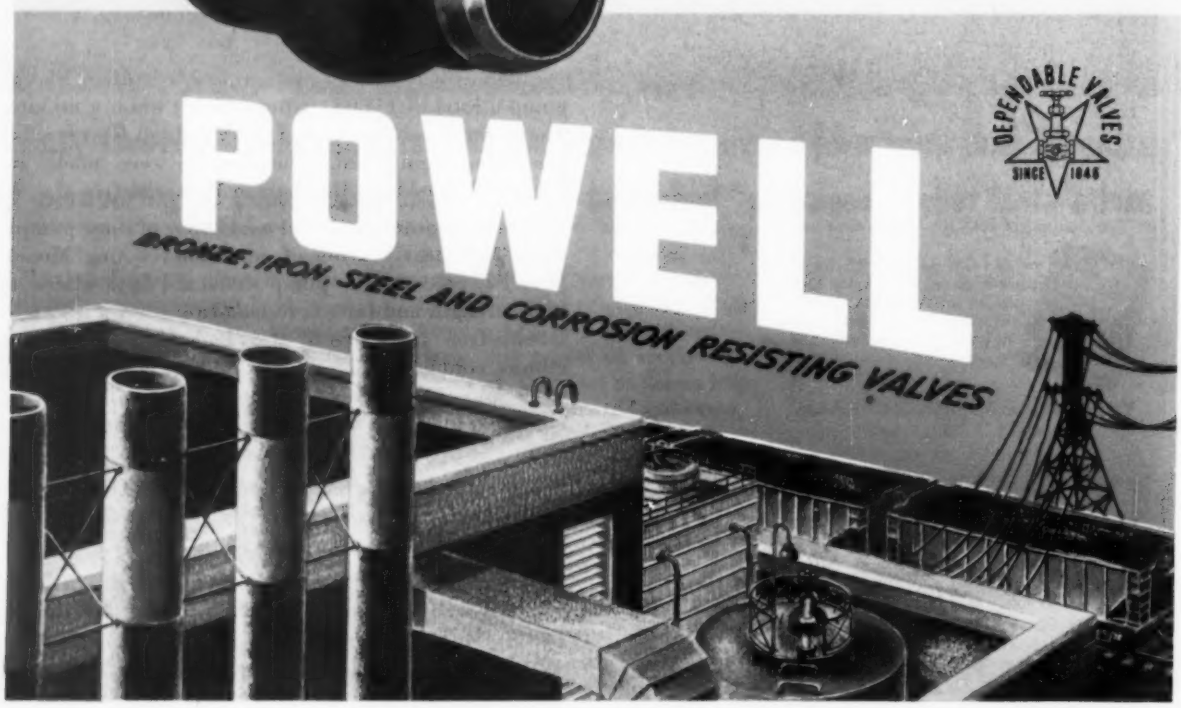


Fig. 16003 W. E. 600-pound Cast Steel Pressure Seal Gate Valve with welding ends. A Powell design for the modern Power Plant. Also made for 900, 1500, and 2500 W. S. P.

# If you want freedom from worry, install POWELL VALVES

**It may not be one of the "Four Freedoms" but freedom from worry is greatly to be desired. In flow control equipment you can have this freedom with Powell Valves—the valves with a record for long, dependable performance with minimum maintenance.**

**The Wm. Powell Company**
**Cincinnati 22, Ohio**

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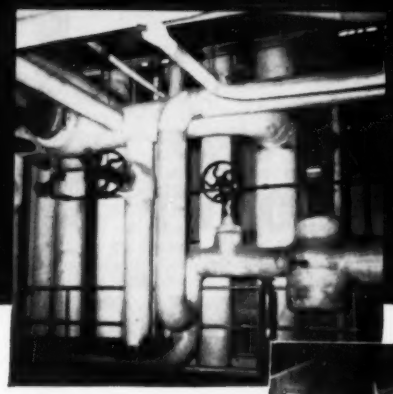
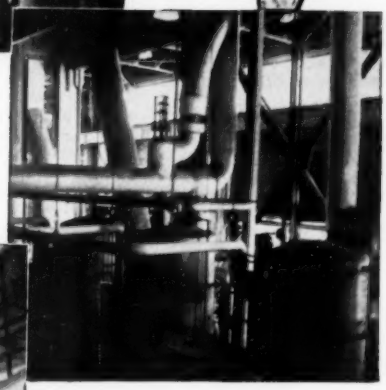
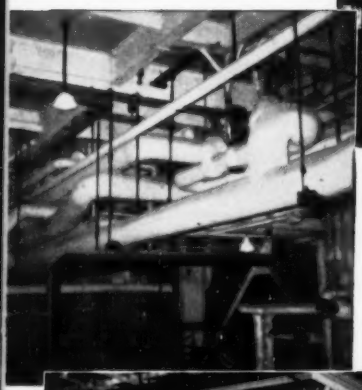
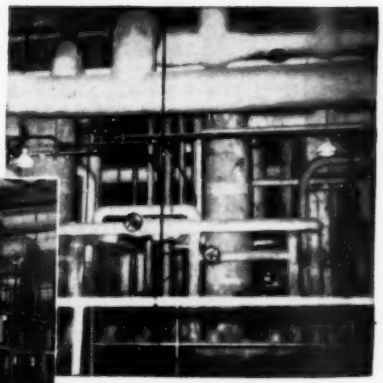
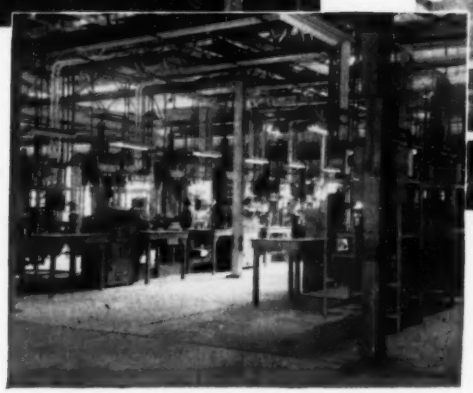
# POWER PIPING that fits like a glove











That is why Blaw-Knox is so often selected to do critical jobs. Whether it's for power or processing, we are well aware that piping requires the specialized knowledge of both engineer and designer as well as the skill and experience of the fabricator. Here you will find the facilities, the staffs, the equipment and the *incentive* to handle any size piping job quickly, authoritatively, economically. And the results speak for themselves during installation as well as over the years ahead.

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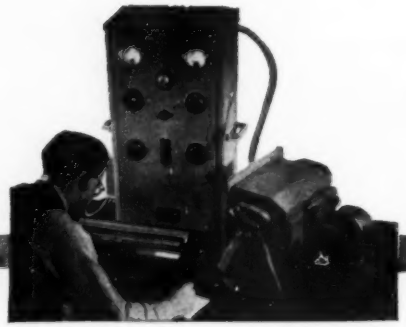
# SMALL PLANTS, TOO!

## CAN PROFITABLY USE THE *Nalco* SYSTEM



*X-Ray equipment, used in the Nalco Laboratories as an aid toward providing positive water treatment results.*

● *Water treatment service for small plants is an important part of Nalco's business.*

This indicates two things:

Small plants find Nalco Service Agreements a profitable investment . . . And

Nalco facilities and services are geared to handle — efficiently and economically — the needs of *any* plant, regardless of its size or the volume of water treatment chemicals used.

If your plant is a small one, you can get the same security from water treatment difficulties as many of the world's largest steam generating stations have with Nalco Service Agreements — and at a cost entirely in line with the size of *your* plant and your problems. Write today for complete details, or call your Nalco Representative.

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**6222 West 66th Place • Chicago 38, Illinois**
*Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario, Canada*

**THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science**

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# Helpful Bulletins

**THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. Circle item numbers of all catalogs wanted on the postage-free card below, detach and mail**

## WATER TREATING

**101 Ion-Exchange Softener** — Duolite Data Leaflet 24, 24 pp, presents Chempro 6-20, a polystyrene cation exchange resin, describing in detail the technical aspects of water softening by means of an ion-exchange resin of this type. Covers such subjects as hardness to sodium ratio, its influence on capacity; effect of magnesium-calcium ratio on capacity; concentration of regenerant brine; contact time, regeneration and rinse rates; exhaustion flow rate; bed depth; turbidity; upflow softening and regeneration. Chemical Process Co.

**102 Automatic Water Softener** — A water softener with independent adjustment and control of backwash, brining and rinsing is described in illustrated Bulletin 612. Discusses operation and advantages of this fully automatic zeolite softener available in conventional and high-capacity designs. Elgin Softener Corp.

## ELECTRICAL

**103 Feeder Voltage Regulator Manual** — The installation, operation and maintenance of voltage regulators is described in 28-pp Manual 01X7002B, 28 pp. Includes connection and installation diagrams, tables for calculating setting of line drop compensator, gives maintenance hints, and describes company's Vari-Amp feature, forced air cooling, oil-sealed inert gas protection. Allis-Chalmers Mfg. Co.

**104 Dripproof Induction Motors** — Speed-torque curves, frame number charts, dimensions and specifications for this company's dripproof induction motors of ½ to 150 hp are presented in this 6 pp brochure. Includes descriptions of variations for optional mounting and special applications. The Lima Electric Motor Co.

**105 Series Motor Parts** — These two 12-pp bulletins cover series motor parts for built-in applications. Booklet GET-2297 is technical in nature and gives selection and application data through the use of charts, curves, formulas, diagrams. Such problems as ventilation, brush life, armature balance and backlash are dealt with. Booklet GEA-5665 highlights available engineering consultation service, reviews typical design problems and describes a line of motor parts rated from 1/20 to 2 hp. General Electric Co.

**106 Starter Selection Guide** — Tips on selecting proper starter for squirrel-cage induction motors rated up to 600 hp at 600 v or less are contained in Bulletin 14B7733. Tells how to choose type of starter, enclosure and operating arrangement, and explains how to determine whether a full or reduced voltage starter should be used. Includes explanation of two- or three-wire control, and hints on selection of heater elements for overload relays. Allis-Chalmers Mfg. Co.

**107 Solderless Terminals** — Here's a 90-pp generously illustrated catalog covering solderless terminals and connectors according to wire sizes. Book provides general information on the line as well as detailed data on pre-insulated and non-insulated terminal types available; wiring and wire termination, also tooling. Well indexed for easy reference, book gives sizes, application suggestions, and includes a section of pertinent engineering data. Also provides a handy selection guide. Aircraft-Marine Products Inc.

**108 Control Relay** — Application and design data on this company's new Type N control relay is provided in Booklet B-5817, 8-pp. Designed for remote control operation, this relay is used to sequence multimotor machines, operate solenoids, obtain pilot control from push-button stations of electrical circuits associated with temperature and pressure regulation. Westinghouse Electric Corp.

**109 Distribution Transformers** — Features of company's distribution transformers in ratings of 167 kva and smaller, 15,000 v and below, are described in 12-pp Bulletin 61B6159D. Includes such mechanical information as standard low-voltage connections and high-voltage bushing arrangement along with recommended installation practice. Allis-Chalmers Mfg. Co.

**110 Power Conversion Units** — Eight-pp Bulletin GEA-5658-B lists design features, advantages, performance, circuits, dimensions and ratings for a line of metallic rectifier power conversion units, rated from 125 to 250 v d-c. Also provides guide to aid in preparing contract specifications which entail company's d-c power supplies and exciters. General Electric Co.

**111 Plug-In Panelboard** — This 8-pp booklet describes company's Noark Flexunit plug-in distribution panelboard, listing specifications and enclosure sizes and covering exclusive features. Suggestions on correct installation included. Federal Electric Products Co.

## INSTRUMENTS AND CONTROLS

**112 Electronic Utilities Control** — New applications of electronic time and program controls are outlined in this folder. These controls, used with proper intermediate electrical devices, offer automatic means of programming starting and stopping of mechanical functions without need for special wiring. Also describes briefly a portable paging system for contact between "transient" personnel and the central office. International Business Machines Corp.

**113 Pressure Primary Element Transmitter** — Bulletin A-708 describes company's Type P2T pressure primary element transmitters for use with automatic electronic controlling and recording systems, giving data on principles of operation. Illustrated with schematic diagrams, phantom views, dimensional drawings. Includes ranges. The Swartwout Co.

JUNE 1953
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**POWER ENGINEERING**

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Company Name.....

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| 13 14 15 | 125 | 126 | 127 | 128 | 129 | 130 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | | | |
| 16 17 18 | 131 | 132 | 133 | 134 | 135 | 136 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | | | |
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Advertised Products and Services (See key number appearing on each ad.)

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| 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | |

Use this space to ask for tear sheets and other information.
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.....

**114 Liquid Level Control** — A single-thyratron electronic liquid level control operating without radio frequency from a single, capacitive type probe is described in Form LL4-453. Illustrates the single-unit control, the probe, and alternative schematic arrangements for installation. Thermo Instruments Co.

## VALVES, PIPING AND ACCESSORIES

**115 Disc Valves** — Circular 558, extensively illustrated, gives dimensions and functions of non-metallic disc valves. Lists in detail those which can be renewed or converted to handle another type of service, simply by insertion of a specially designed disc. The Lunkenheimer Co.

**116 Low Pressure Filters** — Four new pipe line filter models designed for low pressures to 40 psi are introduced in Bulletin 210. Contains specifications, engineering and performance data on filters for the removal of dust, dirt, pipe scale, condensed oil and water vapor from compressed air lines. Dollinger Corp.

**117 Steel Unions** — Six types of cold forged steel unions featuring an improved coating, better over-all protection and more resistance to corrosion are described and pictured in this bulletin. Tells best applications for each type, includes sizes, prices. Rockwood Sprinkler Co.

**118 Metal Hose Manual** — Technical Data Book U-111, 24 pp, includes information on application, temperature ranges of various types of metal and wire braided hose, dimensions, couplings, assemblies. Types of hose manufactured by this company are illustrated and described, including seamless all-metal flexible pressure hose; interlocked suction, blower and conveyor hose; square locked conduits and flexible spout tubing; double wire-braided hose for high pressure applications. Universal Metal Hose Co.

## DUST AND FLY ASH CONTROL

**119 Clean Air for Control Room** — Application Study 106 covers use of electronic cleaners in providing clean air for a steel mill power house control room and disconnect chamber. Explains how these cleaners protect intricate electrical equipment from being coated with airborne dirt which could cause short circuits. Discusses benefits obtained, including no power shutdowns since installation, more accurate instrument operation, greater employee comfort. Trion, Inc.

**120 Self-Cleaning Dust Collector** — Bulletin 915, 6 pp, described company's Type CH-3 self-cleaning cloth screen dust collector. Illustrates engineering features of the unit which uses the principle of reverse air flow for continuous cleaning of the cloth filters. Also discusses features which reduce operating and maintenance costs. Pangborn Corp.

**121 For Fly Ash Collection** — Eight-pp catalog 4P201 on company's Design 4P collections includes a discussion of the problems of fly ash collection. Efficiency curves, arrangements, and standard dimensions given. Flue gas density tables are provided with formula and nomograph for calculating the number of tubes required for any volume and distance. By first determining number of tubes required. Prat-Daniel Corp.

## PUMPS, PUMPING

**122 Positive Displacement Pump** — Bulletin H-20-M describes a recent addition to company's controlled volume pumps — a positive displacement unit for water treating and other industrial applications not requiring extreme accuracy offered by company's Stepvalve construction. Tells applications; includes capacities, materials of construction, prices. Milton Roy Co.

**123 Pumps for Fly Ash** — Illustrated Bulletin F-K-16 describes Fuller-Kinyon pumps for conveying dry fly ash. Discusses and illustrates use of these pumps in power generating stations; also includes drawing showing layout of a concrete products plant which uses fly ash in the manufacture of its products. Fuller Co.

**124 Hydraulic Pumps, Motors** — This data book (approx. 30 pp) describes a new line of heavy duty oil hydraulic pumps, motors and transmissions, providing performance data on dimensional drawings. The line includes variable delivery pumps, variable speed transmissions, and both constant displacement and variable displacement pumps, units particularly adapted to heavy machinery drives requiring precise control of acceleration, speed and reversal. Waterbury Tool, Div., Vickers, Inc

## DIESEL ENGINES

**125 Where to Use Diesel Electric Sets** — Form 30658, 8 pp, titled, "Power," explains the efficient and economical use of diesel electric sets in many industries. Thirteen pictures show their versatility in industrial and other installations, and their use as emergency stand-by power in hospitals and public utilities is also discussed. Back cover of booklet charts 12 sizes of company's electric sets and their rated output for continuous and intermittent use. Caterpillar Tractor Co.

**The Reader Service Card at left needs no postage. Just circle item numbers of all bulletins wanted, fill in name, company, detach and mail**

**126 Two-Cycle Dual-Fuel Diesels** — Sixteen-pp Bulletin 202 covers the design, construction, operation and application of company's two-cycle Duafuel engines. Illustrated with typical installation views, discusses operating advantages, rugged construction of the engines. A schematic diagram of a low pressure gas Duafuel shows starting air, fuel oil and gas systems. Nordberg Mfg. Co.

## MECHANICAL POWER TRANSMISSION

**127 Roller Bearings** — Bulletin 200-C, a 28-pp. revised catalog on self-aligning spherical roller bearings, includes a new width tolerance chart; provides more complete thread, locknut and washer data; a revised interchangeability chart; and has been reorganized for easier reference particularly where adapter type assemblies are concerned. Includes capacity ratings, speed and load information. The Torrington Co.

*(Continued on page 125)*

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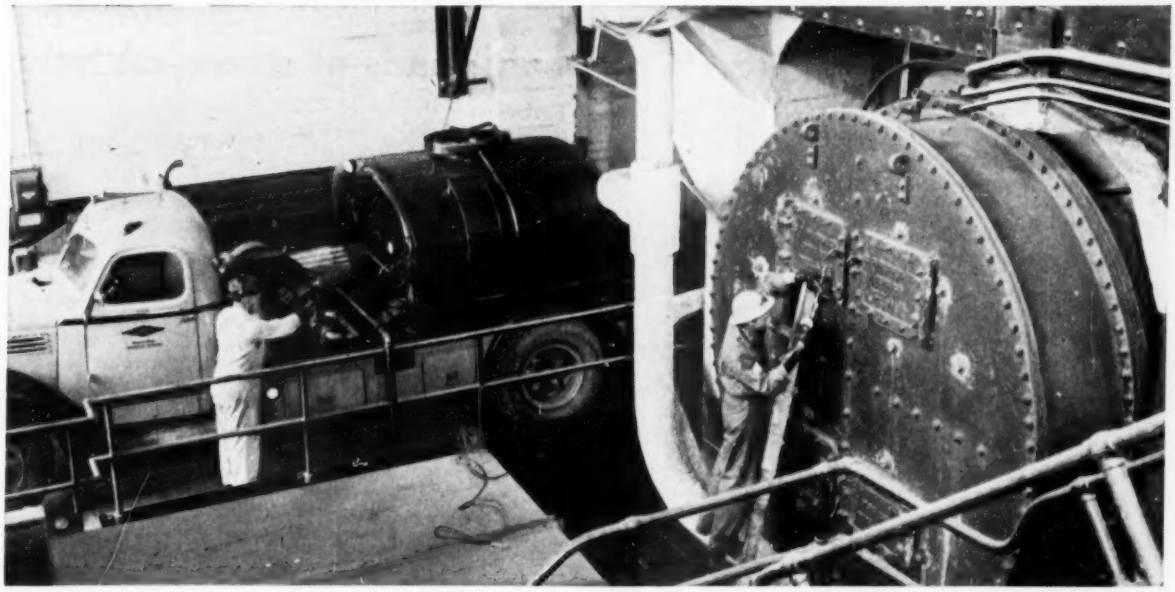
# CHEMICAL CLEANING SAVED 400 TONS OF COAL PER YEAR

## Fly ash, soot and carbonate deposits removed from condenser by Dowell; vacuum increased



Fly ash and carbonate deposits on the water side of an 800-KW turbo surface condenser had reduced vacuum from a normal 28″ to 24″. The temperature of the water leaving the condenser had dropped from 95°F. to 85°F.

These deposits were removed by Dowell Service with specially prepared liquid solvents. Result: the condenser was restored to its normal operating efficiency. The steam requirement was reduced by 2.5 pounds per kilowatt hour. On the basis of 8,000 hours of yearly operation, the plant engineer calculated a saving of at least 400 tons of coal per year.

Dowell chemical cleaning methods can be used on hundreds of different kinds of industrial equipment. Engineers especially trained for this kind of work do the job for you. They apply solvents according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Dowell liquid solvents can go wherever steam or water will flow, reaching places inaccessible to other cleaning methods. Scaffolding is unnecessary. Dismantling and downtime are kept to a minimum.

A call for Dowell Service will bring experienced personnel to your plant within a few hours with all necessary chemicals, pump trucks and control equipment. For complete information and estimates on the cleaning of your equipment, contact the nearest Dowell office, or write directly to Tulsa, Dept. F 24.

# *DOWELL SERVICE*

*Over 100 Offices to Serve You with Chemical Cleaning for:*

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

*Chemical Services for Oil, Gas and Water Wells*

**DOWELL INCORPORATED • TULSA 1, OKLAHOMA**

**DOWELL**

*A Service Subsidiary of*
**THE DOW CHEMICAL COMPANY**

**For more data circle 527 on Post Card**

# Boiler-Burner Team Wins Seven Straight

## Phillips Chemical Company orders Vogt boiler and Coppus-Dennis FANMIX burner combinations to make 1¾ million pounds of steam an hour

When a customer praises a product, that's fine. But when a customer *continually re-orders*, that's conclusive proof of user-satisfaction.

Phillips Chemical Company, Borger, Texas — producer of synthetic rubber — first installed Henry Vogt boilers with FANMIX burners back in 1943. As plant production increased, Phillips again purchased the same equipment — in 1946, and again in 1951.

Today, a total of 7 Vogt boilers equipped with Coppus-Dennis FANMIX burners provide 1,750,000 lbs. steam each hour for the production of synthetic rubber. The boilers are designed for 250,000 lbs. steam peak operation but have been operated as high as 275,000 lbs. per hour. Their performance is typical of the efficiency of boilers equipped with Coppus-Dennis FANMIX burners.

**FANMIX · Better Combustion · Better Efficiency · Higher Ratings**

All Coppus-Dennis FANMIX burners — for gas as well as combination gas-oil — have the exclusive FANMIX action. Their *revolving orifices* give violent mechanical mixing and agitation of gas and air, therefore causing instantaneous and complete combustion with *minimum excess air* (5% excess air is not unusual).

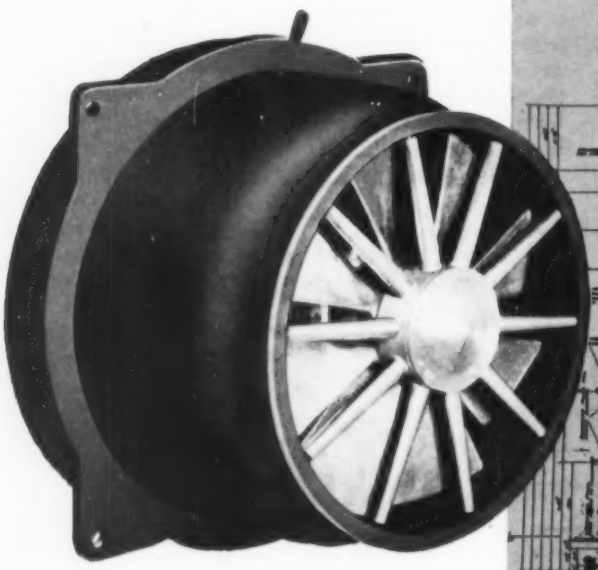
Because of this exclusive FANMIX action, furnace space is not required for mixing and *higher boiler ratings* are thus easily obtained. The burners also have a shorter flame than any other burner and will not cause flame impingement.

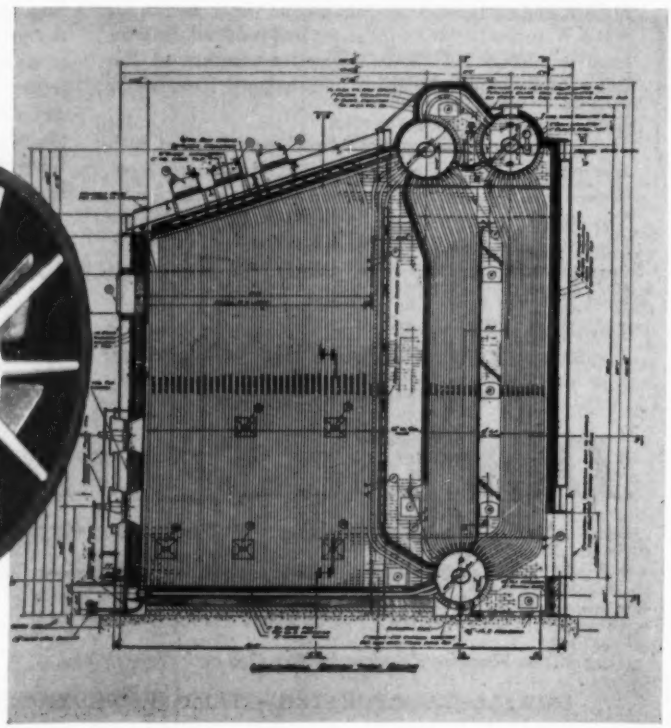
What's more, by incorporating a *fan* as an integral unit, FANMIX burners have *no draft loss* across the burner. As a result, increased ratings are possible regardless of draft conditions.

FANMIX action, with its quick completion of combustion, gives *lower* exit temperatures.

If you are not using Coppus-Dennis FANMIX burners in your present boiler, why not plan now to take advantage of the exclusive FANMIX action? You need no forced draft equipment, increase in stack or increase in furnace volume for FANMIX operation. And you get increased capacity. When specifying FANMIX on *new* boilers, you can plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity — and, of course, *no* forced draft equipment.

For further information, mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory* and *Mining Catalogs*.





**JET REACTION** is utilized to rotate fan which is integral part of burner. Ideal mixture for fast, complete combustion and peak efficiency is caused by automatically proportioned high velocity air passing at right angles through fuel.

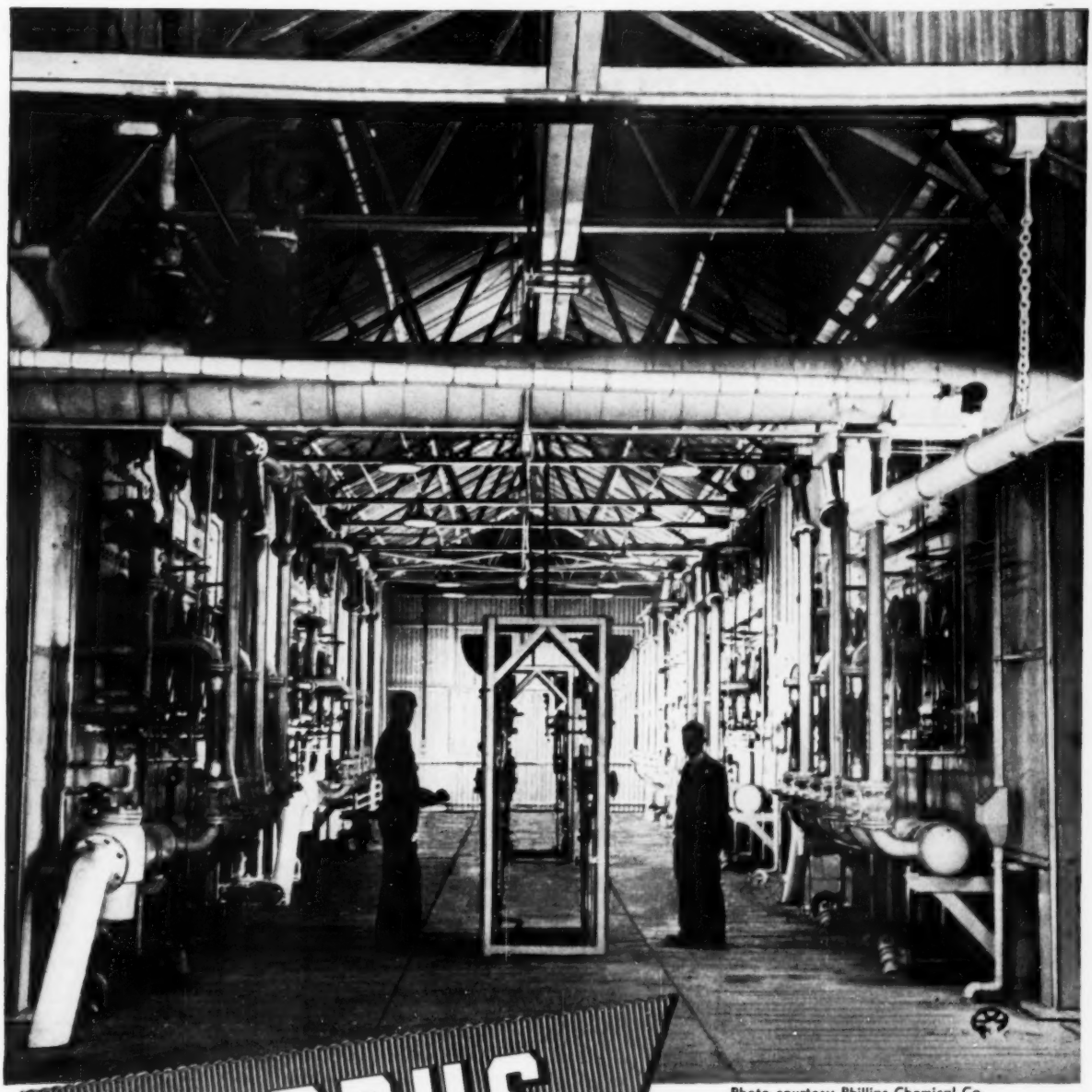


Photo courtesy Phillips Chemical Co.

**HENRY VOGT BOILERS** are here shown installed in the Phillips Chemical Company, Borger, Texas. Boilers use Coppus-Dennis FANMIX burners.

# COPPUS

## FANMIX® BURNER

GAS - - - COMBINATION GAS-OIL

**SEND COUPON** for further information. Coppus engineers FANMIX burners to your individual requirements.

**PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD**

**COPPUS ENGINEERING CORPORATION**
166 Park Avenue
Worcester 2, Massachusetts

Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in ☐ gas ☐ combination gas-oil.

Name.....Title.....

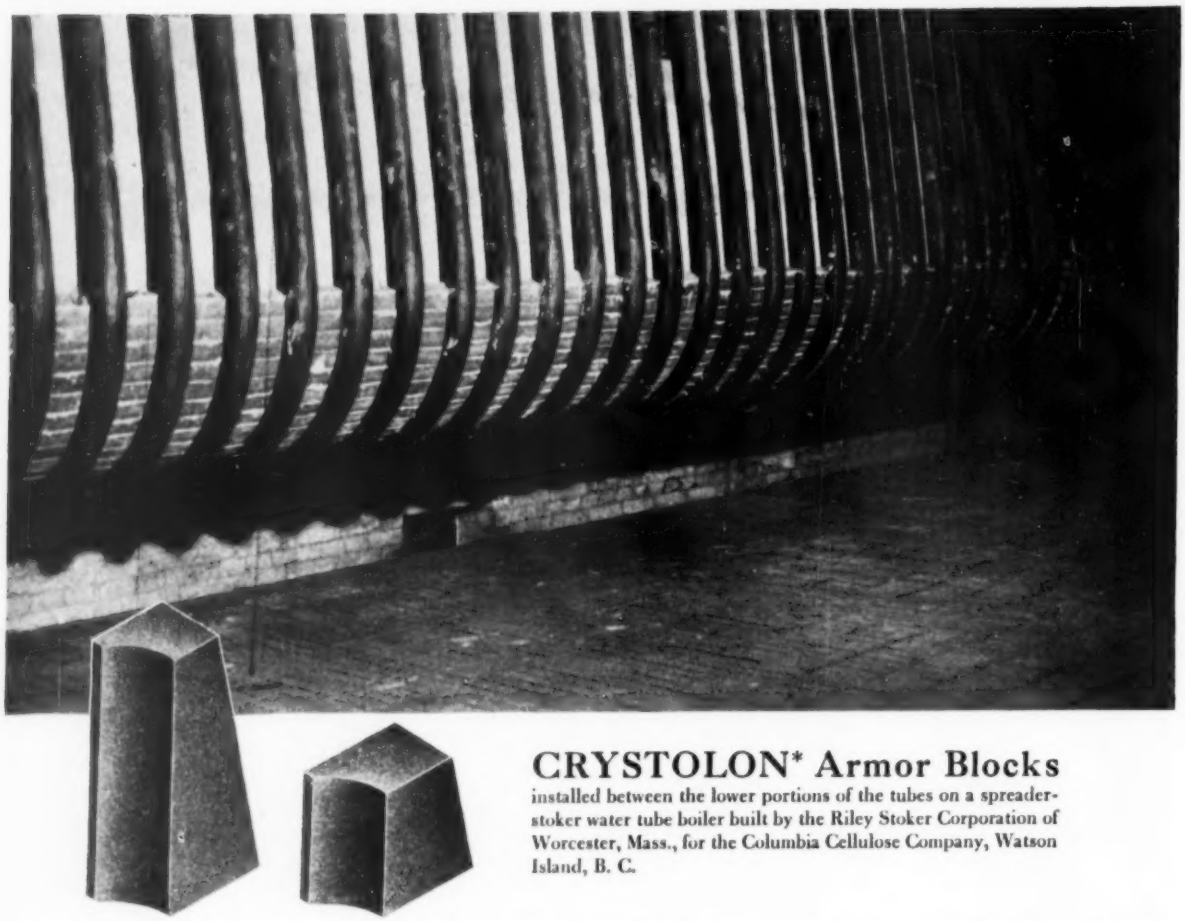
Company.....

Address.....

City.....Zone.....State.....

**For more data circle 528 on Post Card**

# *Here's the most effective*
# *PROTECTION PLUS HEAT CONDUCTION*
## *for your water tube boilers*



## CRYSTOLON* Armor Blocks

installed between the lower portions of the tubes on a spreader-stoker water tube boiler built by the Riley Stoker Corporation of Worcester, Mass., for the Columbia Cellulose Company, Watson Island, B. C.

Thorough-going protection is just one of many important benefits built into this up-to-the-minute boiler by the use of Norton CRYSTOLON armor blocks.

CRYSTOLON blocks readily conduct heat to the unexposed portions of the tubes, which would be impossible with other types of refractories. Due to this high thermal conductivity, and rapid release of heat, the entire armored area serves as an ignition arch to assure complete combustion of the fuel in the ash pit.

Being extremely dense and refractory, CRYSTOLON blocks are unaffected by the ash encountered in this boiler. Thus they form a valuable protective barrier between the insulating brick behind the tubes and the moving ash bed.

***Your own boilers will benefit*** when you protect them with Norton CRYSTOLON armor blocks, wherever flame impingement or fuel erosion is encountered. Besides their longer, more useful service life they are easy to install or remove. Thanks to their interlocking design they can be laid dry or cemented in place, as desired. You can order them for straight or bent tube sections and for any tube diameter and spacing.

Norton Bulletin 862 contains much valuable information on the properties and selection of refractory brick and cement. Ask your Norton Representative for it, or write direct to NORTON COMPANY, 615 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

*Special REFRACTORIES*

*Making better products to make other products better*

**NORTON COMPANY, WORCESTER 6, MASSACHUSETTS**

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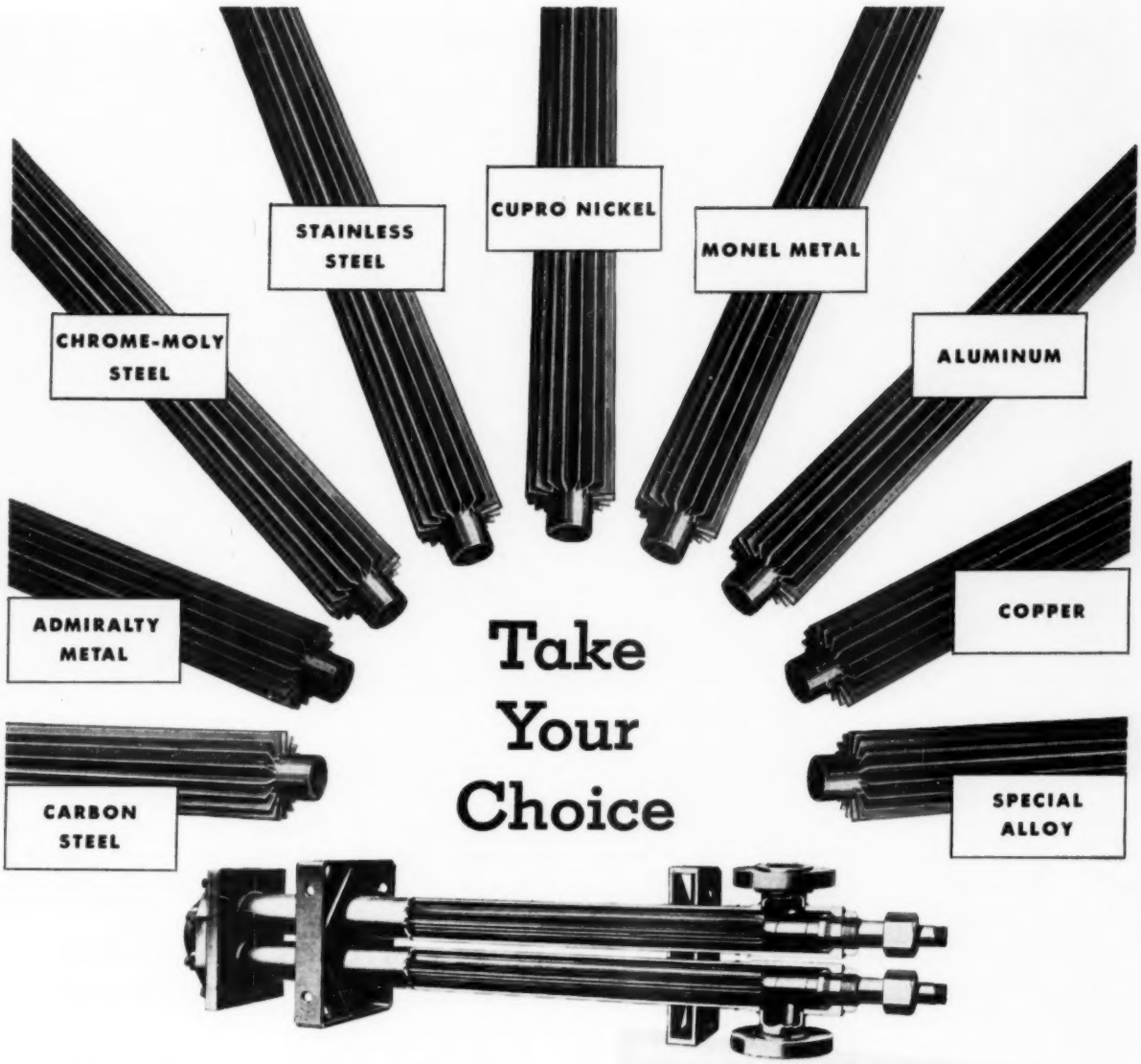


# Take Your Choice

ANY METAL used in heat transfer apparatus can be used for the G-Fin elements of Twin G-Fin Sections.

Therefore, when you purchase these units for your particular heating, cooling, condensing or heat exchange service, you can be sure that the complete heat transfer elements can be made of the most suitable material for the purpose.

This is but one of many Twin G-Fin Section advantages. For the complete story, write for bulletin.

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO

***Note these Twin G-Fin Section Features***

**Simple** . . . has fewer parts than any heat exchanger on the market

**Adaptable** . . . can be used on a wider range of services than any other design

**Standardized** . . . for lower price and quicker shipment

**Convenient** . . . easy to transport, install and maintain

**Durable** . . . proven by 20 years of service and more than 70,000 installed units

**G-R** HEAT TRANSFER APPARATUS **Twin G-Fin Sections**

GR 305

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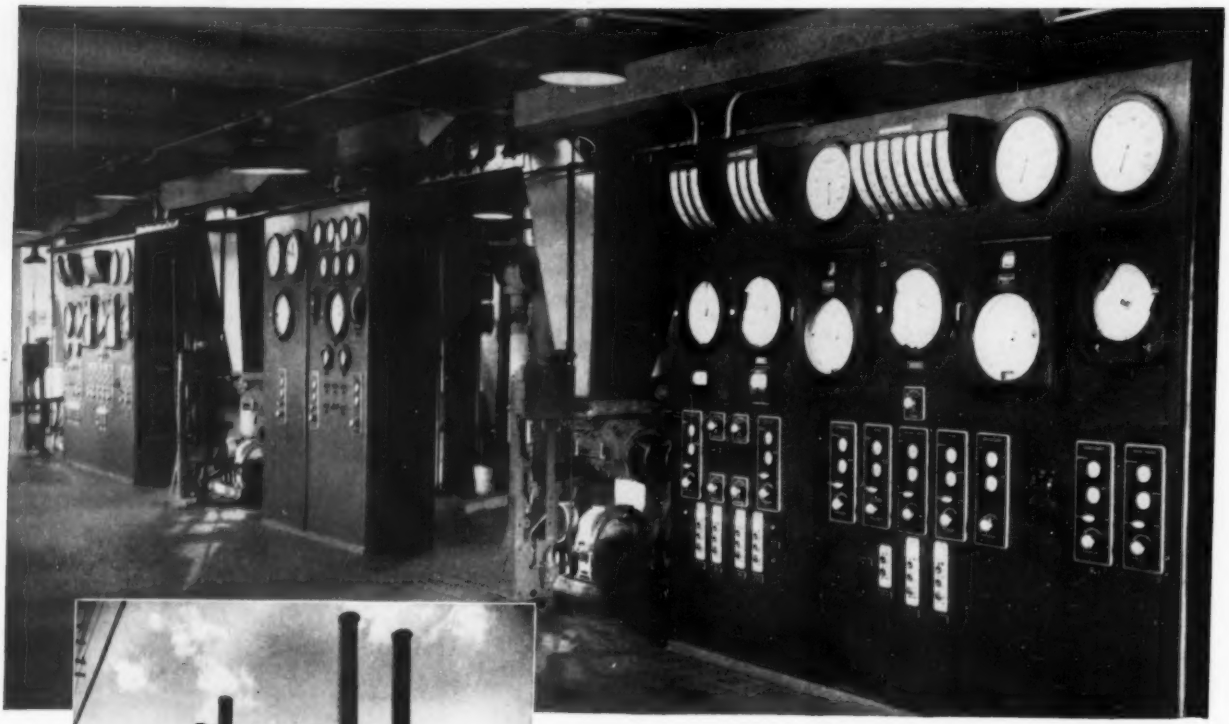
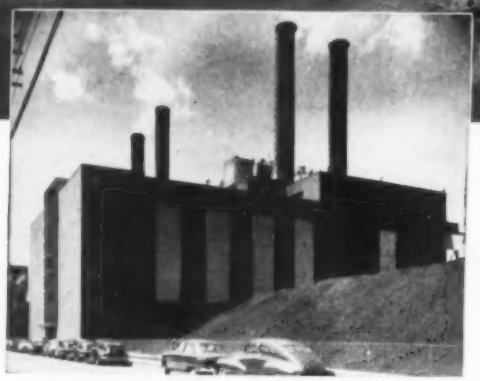




*The Jamestown plant is efficient and modern, inside and out.*

# Control and

## AT JAMESTOWN, NEW YORK MUNICIPAL LIGHT PLANT

**Another Central Station**
**Where REPUBLIC Automatic Combustion Controls:**

***SAVE FUEL*** by maintaining maximum combustion efficiency continuously.

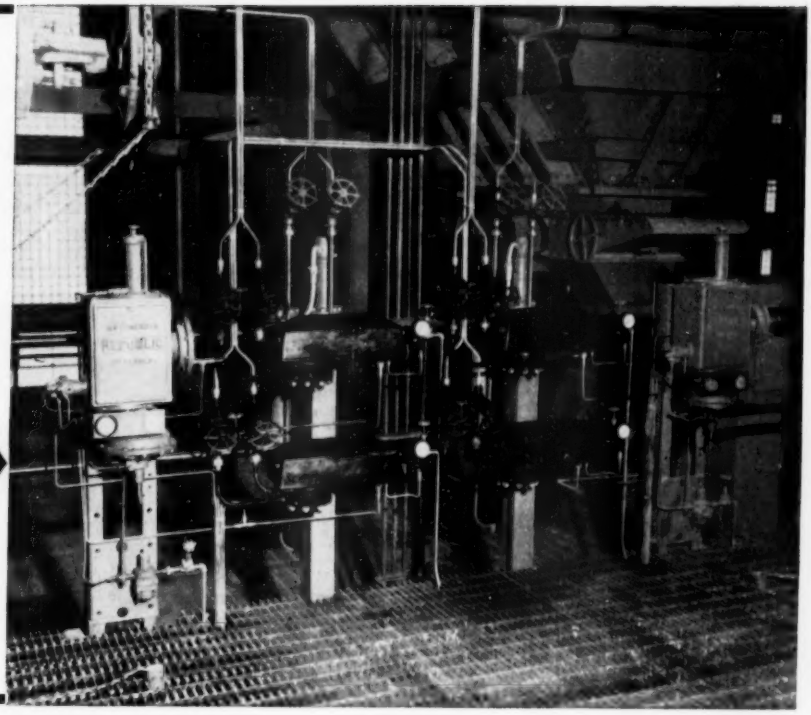
***SAVE MAINTENANCE AND EQUIPMENT*** by holding uniform operating conditions. Chain-of-event type of trouble that frequently develops as a result of incorrect boiler operation is prevented.

***SAVE MANPOWER*** by automatically performing many repetitive adjustments.

***HIGHLY IMPORTANT*** during this critical power shortage, the Jamestown plant meets peak load demands because, with REPUBLIC Combustion Controls, it gets all of the steam output the plant boilers are rated for.

These panels are part of the REPUBLIC Automatic Control System that is used exclusively in the Jamestown plant. When desired, manual operation of the entire boiler system can be made from this location. Panel in the center houses master gauges and other coordinating equipment while panels on either side contain gauges, meters and controls for boilers. REPUBLIC Positioners at left of each panel vary rate of coal feed to pulverizers.

REPUBLIC Regulators and Flow Transmitters are used in the two-element feedwater control system. Rate of feedwater flow to the boiler is changed immediately with a change of either steam flow or feedwater drum level.



# Savings are Automatic

At the Jamestown, New York, Municipal Light Plant, two 150,000 lb. per hr. boilers rated at 900 psig. and 900° F.T.T. supply steam to a 20,000 kw turbine. Steam at 275 psig. and 600° F.T.T. is also supplied through a pressure reducing and desuperheater station to an adjoining older plant.

For maximum efficiency and performance, the entire plant is under automatic control. Steam pressure at the turbine is maintained constant and combustion is held at maximum efficiency for steam loads varying from 40,000 lb. per hr. to 165,000 lb. per hr. Both the Automatic Combustion Control System and the pressure reducing and desuperheater station were furnished by REPUBLIC FLOW METERS CO.

***ONE OF MANY***

This is but one of many power plants that rely on REPUBLIC Instruments and Controls. For more than 37 years, REPUBLIC has specialized in the design and manufacture of automatic control systems for all sizes of power generating stations. REPUBLIC Controls are available for all types of boilers and auxiliary equipment, all kinds of fuel firing (both for single or multiple fuels) and for all load fluctuations. When you specify REPUBLIC Controls, you get the benefit of this complete line of equipment and the services of an experienced engineering staff who know how to put that equipment to use to give you the control system that best meets your requirements.

For complete information about REPUBLIC Automatic Control Systems, send for Data Book S-21 or contact our field engineer nearest you. There's no cost or obligation.

**REPUBLIC FLOW METERS CO.** ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

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# it's 10 years for Copes at Montaup

## ON AMERICA'S FIRST 1935 PSI, 960 F CONTROLLED CIRCULATION BOILER

## boiler water level control

### master excess pressure control • recirculation on light load . . .

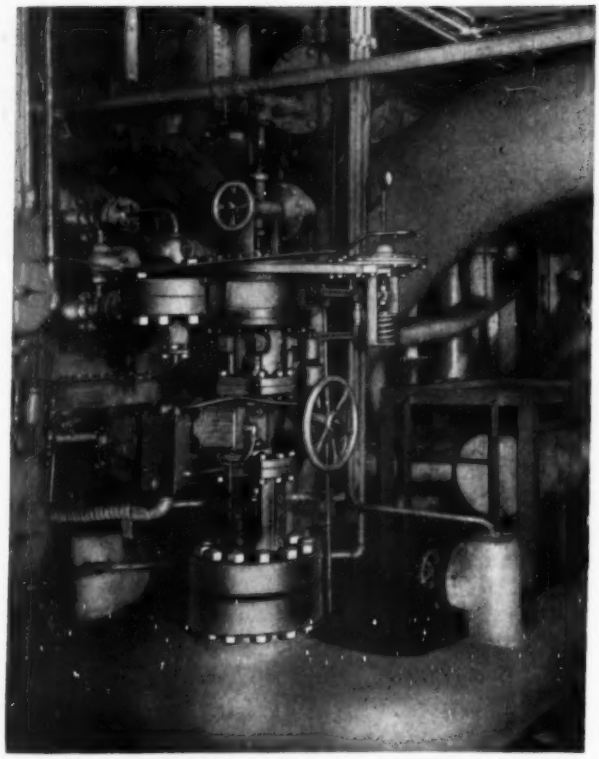
Ten years ago—in October, 1942—America's first large controlled-circulation boiler went into service at Somerset Station of Montaup Electric Company. COPES provided the feed water control for this pioneer installation.

The COPES system begins with master excess pressure control at the boiler feed pumps. It includes COPES Flowmatic Regulators—one in each of the two feed lines—responding to the combined influences of rate of steam flow and boiler water level. It provides automatic recirculation to protect the feed pumps on light loads.

Ten years of dependable performance—handling emergencies as easily as routine operation—prove the soundness of COPES engineering and the durability of COPES equipment.

The engineers who pioneered this outstanding feed-control installation can solve your toughest job—with complete independence from other instruments and controls.

**COPES-VULCAN DIVISION**
**CONTINENTAL FOUNDRY & MACHINE COMPANY**
**ERIE, PENNSYLVANIA**



One of the two COPES Flowmatic Valves feeding the controlled-circulation boiler.

**SIGNIFICANT DATA**

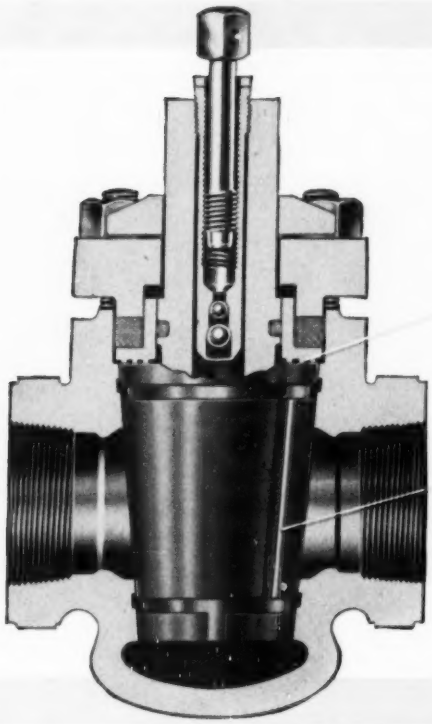
| | |
|---|---|
| *Boiler* | Controlled-circulation, Combustion Engineering-Superheater, Inc |
| *Capacity* | 650,000 lb per hr |
| *Superheater outlet conditions* | 1935 psi and 960 F |
| *Firing* | Pulverized coal or oil; tangential corner firing |
| *Feed pumps* | 3, each with normal capacity of 325,000 lb per hr; discharge pressure 2200 psi |
| *Engineers* | Stone & Webster Engineering Corporation |

## COPES BOILER FEED WATER REGULATION

For more data circle 533 on Post Card

*Oh, I see*

# OIC now offers a complete line of Lubricated Plug Valves . . .



## with two added features

**1** Triple seal gives more effective sealing at shank with ease of turning.

**2** Lubricant grooves that are never exposed to the flowing liquid.

**OIC Tapered Lubricated Plug Valves assure positive, leakproof control of flow . . .**

**O-Ring** . . . under initial compression, gives extra protection against leakage past shank.

**Resilient Packing** . . . completely enclosed in nonrotating metal parts, tends to seat the plug tightly in body without excessive cover tightness.

**Labyrinth Seal** . . . series of concentric rings on gland collar make firm contact between collar and top of plug face, providing additional seal.

**2 Vertical Lube Grooves** . . . 180° apart. When plug is given quarter turn, neither of these grooves is exposed to liquid flow.

**Lubricant Chamber** . . . under pressure from screw piston, lubricant creates upward force during lubrication, tending to free plug for easy turning.

**Plug Lapped to Body** . . . to assure perfect, leakproof fit.

Order in semisteel or steel . . . from your local OIC Distributor. Write for literature describing the advantages of OIC Lubricated Plug Valves.

OIC FOUNDED 1883

**THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO**

**VALVES** | **FORGED & CAST STEEL, IRON & BRONZE, LUBRICATED PLUG VALVES**

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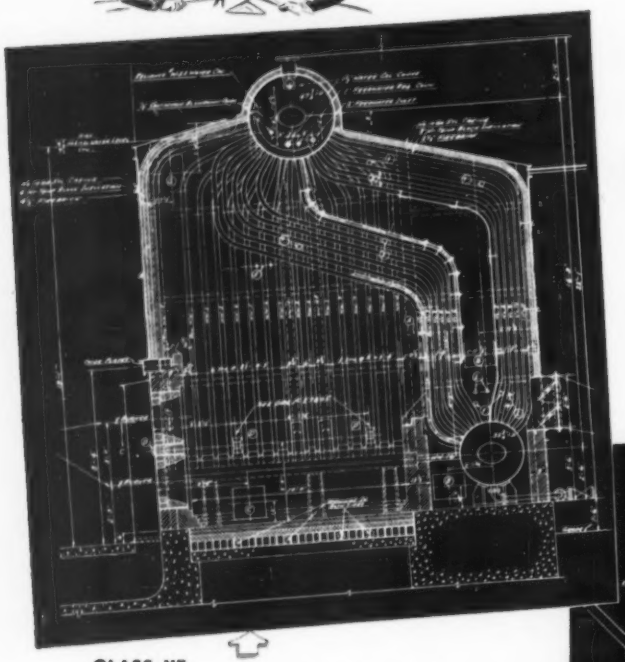
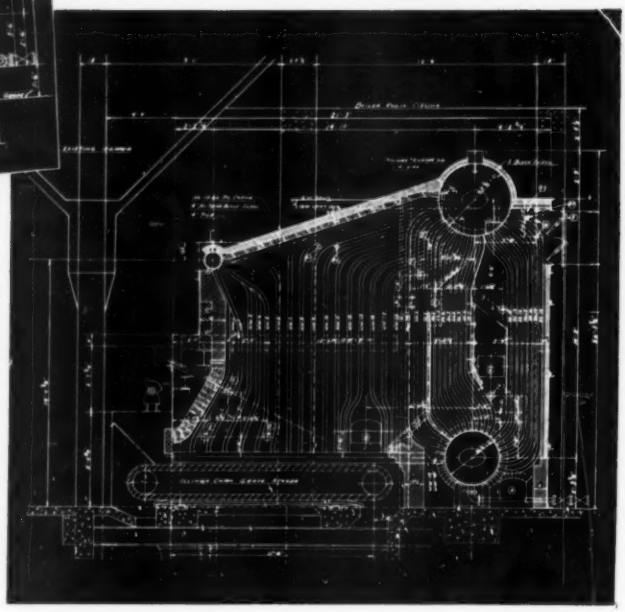
# Industry Approved

# *Two-Drum* STEAM GENERATORS by Vogt



**CLASS VF**
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



**CLASS VS**
The Seelbach Hotel, Louisville, Ky. is served by this 30,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

*A bulletin with general information and showing typical installations is available on request.*

## Typical Users...

**FOOD PROCESSING PLANTS**

**DISTILLERIES • HOTELS**

**HOSPITALS • CHEMICAL PLANTS**

**PETROLEUM REFINERIES**

**HENRY VOGT MACHINE CO., Louisville 10, Kentucky**

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

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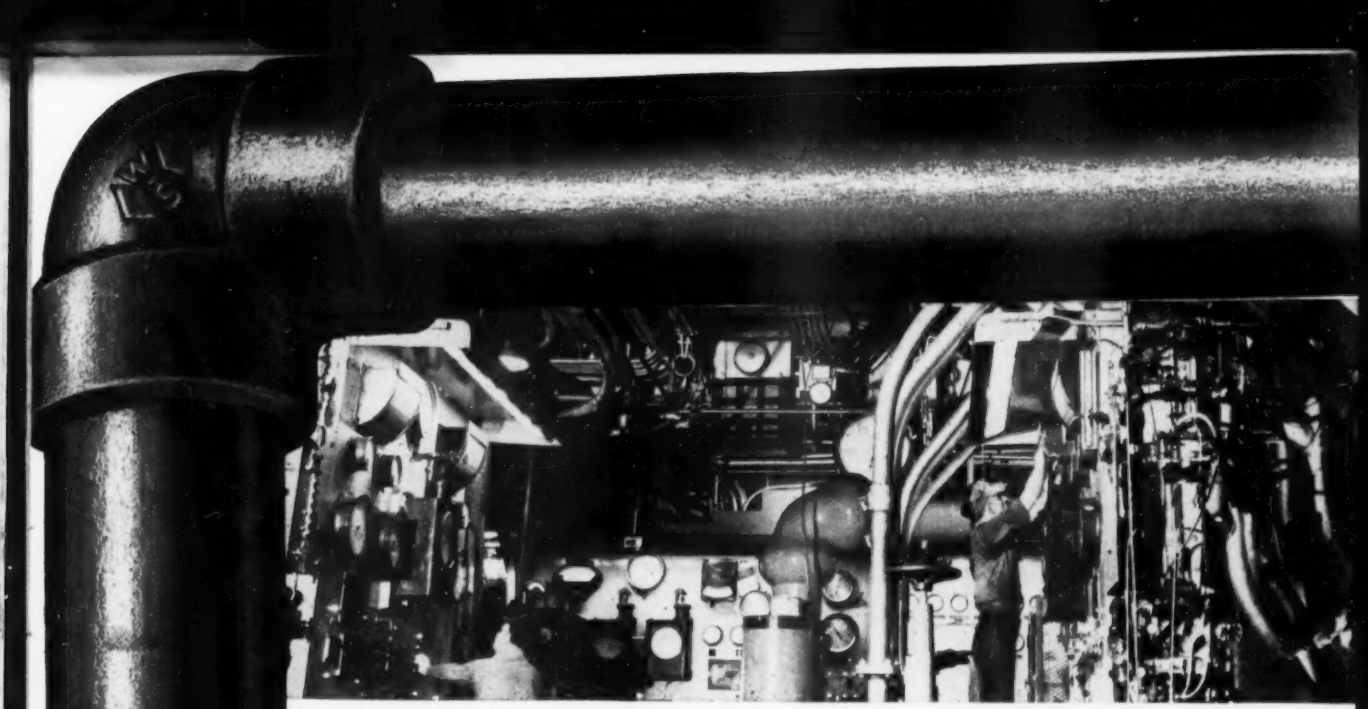


# STOP COSTLY PIPE-LINE FAILURES

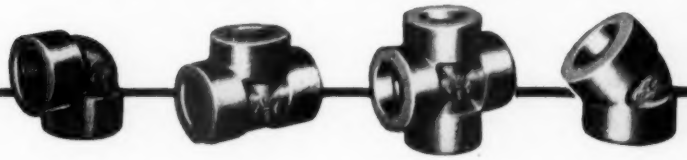
No one knows better than you the increasingly high cost of unscheduled outages due to pipe-joint failures. But do you know just how far it is possible to go toward *eliminating* such failures throughout the life of your piping systems? The answer to this critical problem in production and maintenance costs is FORGED STEEL FITTINGS by the pioneer firm of Watson-Stillman—consultants and suppliers to *all* major industries concerned with pipe joining and maintenance.

Watson-Stillman fittings are FORGED for maximum strength, toughness, and resistance to corrosion, vibration, and shock. More uniformly precise in all dimensions, they are the modern go-between wherever pipes meet permanently.

Leading Refineries, Chemical Plants, Public Utilities, Refrigeration and Industrial Plants throughout the world stay on stream at lowest cost-per-year with the famous Double-Diamond Fittings by Watson-Stillman. Write for literature.

**Screw-End and Socket-Weld Types**

**SOLD THROUGH LEADING DISTRIBUTORS**



## WATSON-STILLMAN FITTINGS DIVISION

### H. K. PORTER COMPANY, INC.

134 ALDENE RD., ROSELLE, NEW JERSEY

9-0-5

# Equipment News

SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-free cards on pages 35 and 125 for your request. Just circle the numbers of the items you'd like to know more about

## 1—GAGE ILLUMINATOR

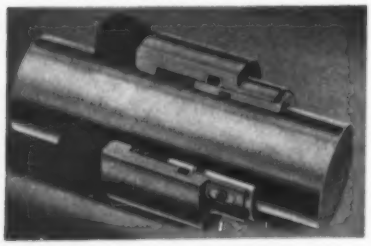
**For boiler water level, uses efficient spot beam mercury lamp**

Enclosed in a sheet steel housing which attaches to the water gage insert, this lamp is said to provide a brilliant illumination of the water level meniscus. Manufacturer especially recommends it for conditions where gages are 40 ft or more from the operating level, as it greatly assists in transferring the meniscus image to the floor stand mirror (if periscope hood is used) or to the eye of the operator. It can, of course, be used at lesser heights if a particularly bright image is desired or where murky atmosphere or light from other sources impairs visibility. A catalog data sheet on this illuminator is available. Reliance Gauge Column Co.

## 2—O-RING MECHANICAL SEALS

**For use on rotating pump shafts, feature simplicity of design**

The small number of parts used in this improved mechanical seal is said to afford easy manufacturing adaptability to withstand any liquid — whether mild,



harmfully corrosive or hazardous — on rotating pump shafts. These sales are designed to provide leakless operation of rotary shafts on centrifugal pumps handling chemicals, petroleum products, pulp liquors and other liquids. They are furnished in Type O, an unbalanced seal for pressures to 200 psi, and Type OB (shown), a balanced seal for pressures to and over 1000 psi. Both can be supplied with single spring or multiple spring, and in either pin-drive or sleeve-drive construction.

The O-rings are available in Teflon, Buna-N, Neoprene, or Silicone, and metal parts contacting the liquid can be furnished in suitable metals. The Garlock Packing Co.

## 3—VOLT-AMP TESTER

**Is junior model, snap-around instrument, economically priced**

The Amprobe Junior is a new snap-around tester built to do a specific job at low cost. Manufacturer announces the selling price as $19.85, including voltage test leads, and says this instrument does a complete testing job. As a snap-around ammeter, it measures current instantly without shutdowns or ammeter connections, and as a voltage meter it gives a voltage reading on a full-size 1.8 in. calibrated scale. Accuracy for both amperage and voltage is given as ± 3 per cent of full scale.

To measure current without ammeter connections you snap the trigger-operated jaws around one conductor (insulated or uninsulated) and you have a reading; to measure voltage, you plug the test leads into the instrument and clip to load. You can choose the range that fits your particular job: Model 10 has a range of 0 to 10 amp a-c; Model 25, 0 to 25 amp a-c; Model 50, 0 to 50 amp a-c, and Model 100, 0 to 100 amp a-c. The voltage range for all models is 0 to 125/25 a-c, and custom ranges for special requirements can be made on quantity orders.

The special significance of the Amprobe Junior is that practically everyone who works with electricity can have a snap-around type tester, company says, including those who require only a single ammeter range or more accuracy than a voltage tester can give them. Pyramid Instrument Corp.

## 4—CONNECTORS

**Liquid-tight, for protecting electrical conductors on machinery**

Connectors in the new ST Series are UL-approved for the protection of electrical conductors on machinery where liquid-tight flexible conduit is used, company states, and they are especially recommended where a liquid-tight raceway is required. Their design provides for an all-metal flaring ferrule which, under compressing action of the tightening nut, is joined with the flexible conduit into a liquid-tight connection.

These connectors are claimed to assure a means of excluding oil, water, acid fumes, chemicals, grease and dirt from the wiring system, and to provide a positive ground between flexible conduit and connectors. Electrical resistance between them is low, and tests are reported to show voltage drop to be less than 10 mv. The connectors are furnished complete with accessories, in straight, 45- and 90-deg types and are available in five conduit sizes from ⅜ to 1¼ in. Appleton Electric Co.

## 5—VERSATILE CIRCUIT TRACER

**Is pocket-size, three-in-one convertible instrument**

The new Desco Circuitracer is announced as a quick-change tester for use in quickly locating grounds, opens, or shorts in dead or live circuits. A simple conversion makes the Desco a

low voltage tester for live circuits, a high voltage tester for live circuits, or a continuity tester for dead circuits.

Manufacturer reports that the instrument has been perfected to trace virtually all types of circuits for continuity and presence of either d-c or a-c voltage. Live circuits as low as 2 v or as high as 600 v can be tested. The unit is sturdily constructed for rugged industrial use, yet weighs only 2½ oz. Delta Electric Specialty Co.

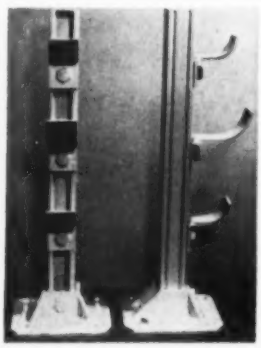
## 6—MAGNETIC CLUTCH

**Offers simplicity of design and several operational advantages**

The Dynamatic Drive is announced as an innovation in magnetic clutches because of its use of stable particles of stainless steel, instead of iron particles. Its value is attributed to design simplicity, lack of wearing parts, fast response, full range of torque transference from zero to full capacity, and easy adaptation to remote control.

The clutch consists of two independent rotating members, a driving element and a driven element, separated by a space filled with small ferro magnetic particles (stainless steel). When one of these members is energized, usually with an electromagnet coil, the particles polarize and bind together. This, in turn, binds the two rotating members together with a force in direct proportion to energy induced.

Advantages claimed for the Dynamatic Drive include smooth engagement without grab or chatter, continuous operation with negligible wear, instantaneous response and absorption of torsionals and peak vibrations. It works as clutch or brake in combination in either direction. The Clark Mfg. Co.



## 7—PIPE STAND

**Is an adjustable, triple-decker unit that's practical and economically priced**

The problem of obtaining a neat piping installation for steam heated process machinery is said to be practically eliminated by this newly designed pipe stand. It is adjustable to allow for floor mis-alignment, and to give steam return and air line piping the proper gravity pitch. Its use permits convenient location of valves and fittings. Company says the unit will sell for less than $10.00, and that an instruction booklet is being prepared to show how laundries and other industries can make use of it to reduce piping installation costs for new machinery hook-ups. Fred H. Schaub Engineering Co.

# NO BONNET JOINT MAINTENANCE HERE

## CRANE LIP-SEAL BONNET VALVES PATENTED STAY ABSOLUTELY TIGHT!

**1500 and 2500-Pound Globe and Angle Patterns**

A small bead of weld metal completely seals the bonnet joint against leakage—in this revolutionary small steel Lip-Seal Bonnet Valve by Crane. Yet the weld carries no mechanical load at rated pressures. If dismantling for inspection is desired, the weld is easily ground off . . .easily replaced. And like its big and famous brother, the Crane Pressure-Seal Bonnet Valve—this new Crane Lip-Seal Bonnet Valve brings many another important refinement. You get a compact, weight-saving structure without sacrificing strength or reducing seat area—a more rigid swivel disc-stem connection—durable plug-type disc—Stellite-faced seating surfaces—and many other features.

Globe and Angle patterns; socket-welding or screwed ends, sizes ½ to 2-inch in choice of steel as required. Full details in Circular AD1902—sent free on request—or check with your Crane Representative.

*THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON*

# CRANE VALVES

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*Branches and Wholesalers Serving All Industrial Areas*

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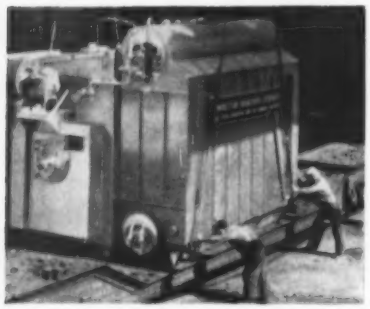
For more data circle 537 on Post Card

## 8—WATER TUBE BOILERS

**Are standardized, packaged units in medium pressure range**

The C-E Package Boiler, Type VP, is announced as a compact, reliable steam generating unit designed to meet the demand for standardized boilers operating in the medium pressure range (up to 250 psig) and for steam capacities ranging from 4000 to 30,000 per hour.

The design of the VP is based on the two-drum, vertical-bent-tube arrangement with a water-cooled furnace in front of the convection surface. In



this new unit there is a higher ratio of furnace-wall cooling to furnace volume than in many boilers of this size and type, a feature said to assure rapid and efficient heat absorption and lower gas temperatures entering the convection bank. It is also said to result in less slag formation.

The boiler is designed for pressure firing of oil or gas, either alone or in combination. It is shipped as a unit with firing equipment, setting, forced-draft fan, and automatic control. Through the use of a centrifugal-type forced draft fan, the VP operates more quietly, company points out, and since this fan supplies air to the furnace at a pressure high enough to overcome the draft loss through the unit, neither high stack nor induced-fan is required. Combustion Engineering, Inc.

## 9—CABLE CUTTER

**Is easily operated hydraulic unit, weighing only 30 lb**

Here is a cable cutter with capacity up to 3½ in. for cutting lead sheathed and power cable (except submarine cable) up to 3000 mcm. It is hydraulic and rests solidly on floor or flat surface. The long swivel type handle eliminates stooping, may be operated at any angle, requires only seven strokes per inch.

According to manufacturer, this new unit is all cutter with no excess weight or bulk — yet it's rugged enough to handle the full power of the 10,000 lb hydraulic jack. This jack is self-retracting and may be stopped at any desired cutter opening by means of a release valve. The cutting edge is protected by brass insert in anvil. H. K. Porter, Inc.

## 10—OIL-ACTUATED CLUTCH

**Is standardized, multiple plate, for general industrial use**

This new clutch, available in Model MOS (single) and MOD (duplex), is designed to provide such features as no-adjustment, higher and more constant torque capacity, compactness, adaptability to remote control and longer service life. The new oil-actuated clutch design is simple, incorporating an integral oil cylinder to clamp the plate stack. Extensive use of snap rings is employed to provide easy disassembly.

Chief advantage attributed to the oil-actuated clutch is that no adjustment is required to compensate for friction plate wear, since the floating or pressure plate is the ram of the cylinder. As the plate stack wears, the ram travel increases automatically. This design feature provides an important correlative advantage. The torque capacity of the clutch for any given oil pressure is always a constant. Another correlative advantage of the no-adjustment feature is that with constant torque capacity, it is often possible to use a smaller clutch. The oil-actuated design permits the torque capacity to be directly proportional to the applied oil pressure, it is explained, since this pressure creates clamping force. Twin Disc Clutch Co.

## 11—LIQUID COOLER

**Simplifies and speeds up boiler blowoff and water sampling**

The Heat-X Cooler features two copper tube circuits cast in a single aluminum block, making a rugged unit of great strength. All coolers are tested to 1500 psi pressure. In operation, coolant flows through one circuit, and the liquid to be cooled flows through the other circuit. Cast-in-aluminum construction permits highly efficient heat transfer within a compact unit, company says, but stainless steel tubes can be supplied if desired. The Heat-X-Changer Co.

## 12—5000 PSI MANOMETER

**With stainless steel range tubes, temperature compensation**

This new high pressure mercury manometer is designed for routine operation at pressures to 5000 psi. It also offers such features as company's Magnabond magnetic coupling between float and follow-up linkage to eliminate problems of pressure-tight bearings, lubricants, and fluid leakage; stainless steel float and range tubes to enable the manometer's use with sour crudes and other corrosive fluids; a free-riding float, permitted by the magnetic coupling, to seal against upper or lower O-rings in the float chamber and provide a positive check against loss of mercury on overrange; and an inherent temperature-compensating feature to afford billing-accuracy measurement under varying ambient conditions. The manometer is also offered with a recorder which can be used with McGaughey-type continuous integrating mechanisms.

This manometer is essentially a conventional U-tube mercury instrument. The float operates through a 2-in. linear travel in the low pressure range tube, to provide good sensing accuracy. Despite this long float travel, the manometer uses relatively little mercury because, with the magnetic coupling, relatively little force is required to move the float even at low pressure differentials. Range tubes are available for 100, 200, and 400 in. of water standard. Fischer & Porter Co.

Want more details on these new products? Use post cards on pages 35 and 125.

## 13—OPPOSED PISTON ENGINE

**Compact, heavy duty unit, rated 75 ph per cylinder at 1200 rpm**

The Model 385¼, a new small opposed piston engine, is offered to meet the demand for a compact, heavy-duty diesel for applications in the 225 to 750 hp range. It has a 5¼-in. bore and 7¼-in. stroke. Manufacturer emphasizes that this engine is designed for continuous heavy duty service despite the low weight of 7100 lb for the 225 hp unit, and that construction is sturdy and piston speed and bearing loads are conservative.

Development of the new engine stems from the success of company's 8⅛ by 10 in. opposed piston diesel, used during World War II for submarine service, and later made available for civilian applications. Company points out that like the larger units, this new model can be equipped to operate as an oil-burning diesel, as a dual-fuel, or as a spark ignition gas engine. It can be mounted on skids as a portable unit.

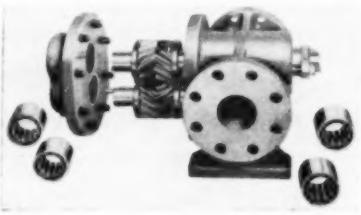
The general design of the engine is characterized by a pair of pistons in each cylinder, operating in opposite directions, and with a common combustion space formed by the heads of the pistons. The upper ones, controlling the scavenging air inlet ports, are connected to an upper crankshaft, and the lower pistons, controlling the exhaust ports, are connected to a lower crankshaft. The engines are self-contained units with attached pumps and auxiliaries. Fairbanks, Morse & Co.

## 14—ROTARY GEAR PUMP

**In 1 to 500 gpm capacities; offers simplicity of design, economy**

Primarily for positive displacement of lubricating liquids, the Hydrex is intended to handle fluids and semi-fluids, 32 to 250,000 SSU. Capacities are 1 to 500 gpm; 300 psi for continuous duty, 500 psi for intermittent service.

According to manufacturer, the simplicity of this pump makes possible high quality at low cost. This design simplicity is indicated by the use of



only two castings (for body and head); only two moving parts (the rotors); and only one stuffing box (under suction pressure). No inner races are needed in the bearings as the shafts are hardened and ground at the bearings, it is pointed out. Special features announced for the pump include precision made gears, heavy duty roller bearings, and shaft hardened and ground at the stuffing box to minimize wear. Sier-Bath Gear & Pump Co.

## 15—PRESSURE SWITCH

**With variable action value; for liquid, gas or water systems**

The Meletron Model 314 comes in six classes of proof pressures (to 500, 1500, 3000, 4500, 6000, and 12,000 psi), to provide accurate sensing of system pressures over an adjustable range of

# Whatever your fuel needs, we have a coal that is

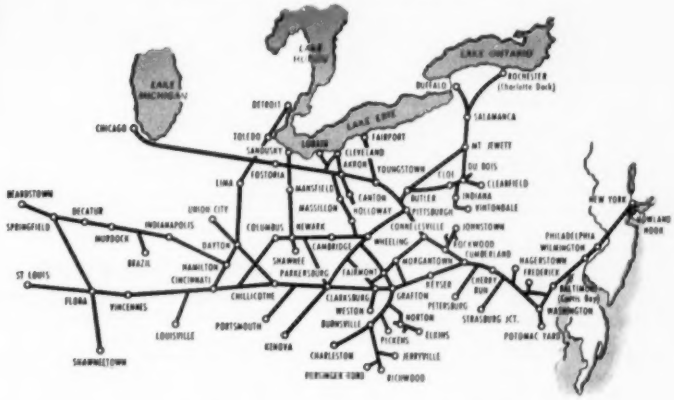
# *Just the Ticket!*

● In fact, you can write *your own* ticket—for the vast Bituminous fields served by the Baltimore & Ohio contain excellent coals *in wide variety*. For centuries to come, these coals will be available—a dependable source of low-cost heat and energy.

Modern mechanization at the mines assures low costs as well as uniform size and quality. The location of the fields—close to industry's front door—contributes to low transportation expense. Storage is economical because costly facilities are not required. And with the help of new combustion methods and equipment, Bituminous offers its users an increased burning potential.

*ASK OUR MAN!* He can give you worthwhile advice as to supply sources and burning methods for the particular coal you need. The efficiency, economy, and cleanliness of B&O Bituminous today will be a revelation!

**BITUMINOUS COALS FOR EVERY PURPOSE**




LINKING 13 GREAT STATES WITH THE NATION

B&O

# BALTIMORE & OHIO RAILROAD

**Constantly *doing things* —better!**

**For more data circle 538 on Post Card**

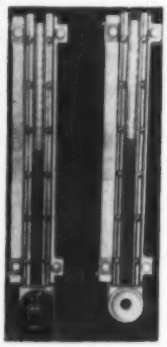
15 psi to 10,000 psi, it is announced.

The switch will actuate at any predetermined pressure over the adjustable range; and is available with external adjustment if setting requires frequent changes. The variable action value ranges from 10 to 2000 psi, depending on the switch class. Actuation may be on increasing or decreasing pressure, automatically reset by snap action of switch. Barksdale Valves.

## 16—GAGES

**Are designed for liquid level and tank filling applications**

Glo-Rod Gages are described as particularly useful for colorless liquids and daylight sight readings, giving instantaneous checks without light loss through reflection. Normal illumination is declared sufficient to transmit light upward through the plastic rod causing the liquid to appear as dots below the surface of the liquid and as dashes above the liquid. When used in darkened areas, the gage can be illuminated by a flashlight, or a compact electric unit can be furnished when permanent lighting is required. Where a gage is needed for use in restricted space, certain models are available with reading face offset 30 or 90 deg.



These gages require no separate mounting brackets when attached directly to tank walls; but an automatic cut-off valve for eliminating danger of large fluid losses can be supplied where piping is necessary. Already widely in use in the railroad industry, Glo-Rod Gages come in a variety of models and sizes for industrial use. They are reported to be particularly successful on diesel fuel and water tanks. Nathan Mfg. Corp.

## 17—COUNTING DEVICE

**Keeps track of off-normal signals shown on the annunciator**

It is often important to know the frequency at which any point of an annunciator system is off-normal. To supply this information the Model TC Tele-Counter keeps continuous count of every off-normal signal as indicated by manufacturer's Tel-Alarm Annunciator. Any number of individual alarm points of the system may be selected for totalizing — or the entire unit may be equipped with the counter. Repeater window markings on the totalizer unit identify each associated signal station on the main annunciator board.

In addition to the individual totalizers, the Model TCS is designed with signal sequence selector, whereby the initial off-normal signal at the annunicator is immediately indicated by an illuminated window directly above the corresponding counter totalizer. This is essential in determining which equipment or process step failed first.

Both types of Tele-Counters can be adapted to existing Tel-Alarm Annunciator Systems. The compact Tele-Count unit can be installed at the annunciator panel or at a remote point for supervised control. Complete information is given in Bulletin TCS. Tigerman Engineering Co.

## 18—COMBUSTION ANALYZER

**Is portable, all electric unit powered by a dry cell battery**

The Model 140-C measures per cent $CO_2$ (0 to 20 per cent), temperature (100 to 1000 F), and draft (0 to 0.3 in. water) on one meter. Its features include a glass coated electronic thermistor, gas analysis cell with built-in temperature compensator, filter-drier, compensated thermocouple lead, and two 30 in. probes (longer probes may be had at extra cost). Flue gas temperatures are taken at the same point as the $CO_2$ measurement, and a series of readings may be taken without moving probes. Victory Engineering Corp.

## 19—AIR VIBRATOR

**Is 2-in. piston diameter unit, featuring easy portability**

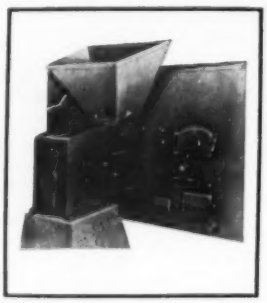
The LSRR Air Vibrator is reported to be finding wide acceptance as a practical means of eliminating arching, bridging and sticking conditions in bins, hoppers, chutes and other equipment handling granular materials. The cast steel male bracket on the 2-in. LSRR is designed to fit snugly into the female bracket and step up unloading of materials having a tendency to pack down. The vibrator is designed to start and stop instantaneously. According to manufacturer, it is ideal on applications where one vibrator can serve several bins.

Over-all dimensions of the unit are length, 10 in.; height, 5 in.; width 5 1/2 in. It is easily portable, weighs only 30 lb. Cleveland Vibrator Co.

## 20—STOKER

**Is single retort, underfeed unit; hydraulically driven, controlled**

The Fluid-Ram is a compact new stoker designed to provide unobstructed access to fire doors, sifting doors, and ashpit doors. The hydraulic fuel feed control offers a broad range of fuel regulation,



making the unit well suited for automatic combustion control where wide load range operation is desired. Details on this stoker are given in Bulletin SB-47. Erie City Iron Works.

## 21—WHEEL PIPE CUTTERS

**Available in two sizes, are engineered for easy handling**

This newly redesigned line of wheel pipe cutters comes in two popular sizes: No. 2 for 1/8- to 2-in. pipe, and No. 4 for 2- to 4-in. pipe. According to company, the changes in cutting design permit power to be applied directly to the cutter wheel, so there is no wasted pressure or effort. The cutter wheel, being close to the slide track of the guide block, cuts down slide block wobble and affords good tracking and finer accuracy when pipe is cut. The tools are coated with a tough, oven-dried lacquer finish. Beaver Pipe Tools, Inc.

## 22—GASKETS

**Metal aligning, are designed for flange selling applications**

Vic-O-Seal Metal Aligning Flange Gaskets are intended to prevent leakage due to misalignment. Company says they are an economical, efficient and practical method of joining flanges, combining strength and safety, and requiring no maintenance.

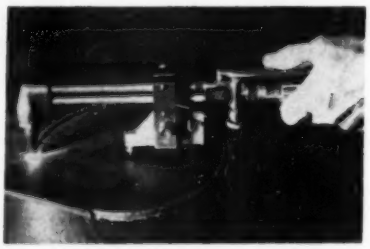
These gaskets are designed to provide a positive seal on misalignment up to 6 deg, and are usable with standard fittings. They are available with O-ring seal or metal-to-metal fit can be used for fluids, gases and air. Vickers Inc., Div., The Sperry Corp.

## 23—CUTTING GUIDES

**Are designed for use with individual gas flame metal cutting torches**

This series of precision type guides are designed to provide shop mechanics with simple, low cost attachments for the accurate cutting of circles, straight lines, bevels and other shapes. Special training or skill isn't needed for their use, manufacturer states, and as emergency or standby equipment they provide a means for quickly producing parts that would ordinarily take days if ordered from an outside source. Also, they permit worthwhile economies when only a few parts are to be produced.

Made in styles to fit various makes of torches (from 70- to 90-deg models), the guides are of three principal types:



a small circle guide (shown) for cutting circles of 1- to 15-in. dia; a large circle guide for circles of 10- to 66-in. dia; and a straight-line guide which can be used for straight and 60-deg or 45-deg bevel cutting. The guides can be attached to torches in a few minutes time and finger-tip adjustments require no tools. Guides are offered singly or in kits. New Era Engineering Co.

## 24—ANTI-RUST PAINT

**For use right over rusted surfaces, comes in wider color range**

Formerly available only in black, clear and aluminum, PCA Anti-Rust Paints are now also furnished in light gray, oxide red and chrome green. Made with a blend of vegetable oils and processed Menhaden, plus rust-inhibiting chromates, the paints are claimed to stop rust for years in one application. Manufacturer says they can be brushed, sprayed, rolled or dip applied over rusty surfaces — without wire brushing, scraping, sandblasting or use of primer coat. The paints are said to absorb surface rust, penetrate to clean metal beneath and seal it against further rust or corrosion. Bulletin L-7287 describes the new paints. Paint Corp. of America.

# Reduce Solids Concentration *with* EFFECTIVE BLOWDOWN

**ALLIS-CHALMERS WATER CONDITIONING**
Equipment — Chemicals — Service

**You Need An Effective** blowdown schedule to reduce solids concentration and limit heat losses in your system. Planning your schedule is easier after you've read Allis-Chalmers water conditioning Bulletin 53. It tells how to choose between a manual and a continuous system. It explains factors involved in sludge removal. And it discusses effects of alkalinity and silica concentration.

### Part of Practical Library

Bulletin 53 is one of a series of Allis-Chalmers bulletins on water conditioning problems. These bulletins are the result of Allis-Chalmers experience in solving water problems for every industry, as well as the company's long background in the design and manufacture of steam turbine and power plant equipment.

### Get Complete Service

Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed in all water treatments. And you can get equipment needed for any system.

**COMPLETE TEST KITS for making standard feedwater and boiler water tests are supplied by Allis-Chalmers for field use. When needed, modern testing equipment and research facilities are available in A-C laboratories.**

For your copy of Information Bulletin 53 on blowdown, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C district office to have an Allis-Chalmers representative consult with you on your water problems.

A-4008

# ALLIS-CHALMERS

**For more data circle 539 on Post Card**

# POWER PLANT *Construction News*

**Nogales, Ariz.** — Citizens Utilities Co. has tentative plans under way for expansion in local oil engine-operated electric power plant, with installation of equipment for increased capacity. Project reported to cost over $300,000.

**Anaheim, Calif.** — Delco-Remy Division, General Motors Corp., Anderson, Ind., automotive starting, lighting and ignition equipment, electric storage batteries, etc., plans boiler plant at proposed new factory at Anaheim, to occupy portion of 90-acre tract of land, lately purchased. Plant will consist of several units, given over largely to battery manufacture, and is reported to cost over $2,500,000. Erection will begin this spring.

**Santa Ana, Calif.** — United States Rubber Co., Inc., 1230 Ave. of the Americas, New York, N. Y., plans steam power house at new mill near Santa Ana, for manufacture of foam rubber. A number of buildings will be erected for processing and general production. No official estimate of cost announced — will represent a sizable investment. Work is expected to begin this spring.

**Wilmington, Del.** — Delaware Power & Light Co., 600 Market St., is arranging an expansion and improvement program for next 36 mos. to cost about $35,000,000, including additional generating capacity, power substations, transmission lines and other operating facilities. Of this amount, approximately $13,750,000 will be used for expansion at Edge Moor steam-electric generating plant, recently noted in these columns, with installation of new 78,000-kw. turbine generator, high-pressure boilers and auxiliary equipment.

**Mulberry, Fla.** — F. S. Royster Guano Co., Royster Bldg., Norfolk, Va., plans boiler house at new plant at Mulberry, for production of triple superphosphate fertilizers. Plant will comprise a number of buildings and is reported to cost close to $3,000,000. Work scheduled to proceed at early date.

**Urbana, Ill.** — University of Illinois, Urbana, has plans under way for extensions and improvements at power plant at institution, with installation of additional equipment. Estimated to cost about $900,000. Program will be carried out in connection with a number of new buildings at college, remodeling and improvements in certain present structures, entire project to cost about $20,000,000, over a period of months. Ernest Stoeffer, Administration Building at university, is supervising architect.

**Plainfield, Ind.** — Public Service Co. of Indiana has budgeted an expansion and improvement program in plants and system during next 36 mos. to cost close to $110,000, including extensions in generating capacity at different stations, power substations, transmission lines and other operating facilities. It is proposed to dispose of stock to amount of $30,000,000 during present year as part of gross amount noted.

**Anamosa, Iowa** — State Office of Executive Council, State Capitol Bldg., Des Moines, Iowa, William S. Beardsley, chairman, has authorized an appropriation of $1,000,000 for construction of new power house at men's reformatory, Anamosa. Plans will be prepared soon. Work will be carried out under direction of State Department of Buildings.

**Pittsburg, Kan.** — Kansas Gas & Electric Co., 201 No. Market St., Wichita, Kan., will begin work on superstructure at early date for new steam-electric generating station on west bank of Neosho River, Pittsburg, directly opposite present plant on east bank of that stream. It will be equipped for initial capacity of 70,000-kw., with generating unit of that rating, high-pressure boilers and auxiliary equipment. No official estimate of cost announced. Completion is scheduled in 1954.

**Louisville, Ky.** — Ford Motor Co., Dearborn, Mich., plans power house at proposed new automobile assembling plant at Louisville, where tract of about 13 acres of land as been acquired. It will comprise a main one-story building, about 300,500 sq ft floor space, and several auxiliary structures, and will have a capacity of approximately 370 cars per day. Entire project will represent a reported investment of close to $40,000,000.

**Baton Rouge, La.** — Foster Grant Co., Inc., Leominster, Mass., plastic products, plans power house at proposed new plant at Baton Rouge, where site is being acquired. It will comprise several units, equipped for large output. Cost reported over $3,000,000. Work scheduled to begin in near future.

**New Orleans, La.** — New Orleans Public Service, Inc., 317 Baronne St., plans extensions and improvements in plants and system to cost about $29,000,000. Project will include enlargement of present A. B. Paterson steam-electric generating plant on Industrial Canal, with installation of new 82,000-kw. turbine-generator, making fourth unit at plant, high-pressure boilers and accessory equipment.

**Needham, Mass.** — American Can Co., Atlantic Division, 100 Park Ave., New York, N. Y., plans power house at new plant at Needham, where large tract of land has been secured, for manufacture of paper milk containers. It will consist of a main processing and production building, and several smaller structures, reported to cost over $2,500,000. Work is scheduled to begin this spring.

**Cedarville, Mich.** — Michigan Limestone Division, United States Steel Corp., Guardian Bldg., Detroit, Mich., plans power house at proposed new limestone mining and processing plant near Cedarville, Mackinac County, where tract of 10,000 acres of land has been secured. Plant will be equipped for a capacity of 250,000 tons per mo., and is reported to cost in excess of $5,000,000. Work will be placed under way soon.

**Johnstown, Pa.** — Pennsylvania Electric Co., Johnstown, has arranged an expansion and improvement program in plants and system during next 24 mos., to cost about $95,000,000, including increased generating capacity, power substations, transmission lines and other operating facilities. Company plans extensions in steam-electric generating station at Shawneesville, Pa., with installation of two new generating units, high-pressure boilers and auxiliary equipment, estimated to cost close to $60,000,000, including power substations and transmission lines.

**Clarksville, Tenn.** — International Minerals & Chemical Corp., 20 North Wacker Dr., Chicago, Ill., plans boiler plant at new fertilizer works near Clarksville, where tract of 32 acres of land has been acquired. It will consist of a number of buildings for processing and production of various plant foods, with rated output of 20,000 tons per annum. Cost reported in excess of $500,000. Work is scheduled to begin this spring.

**Nashville, Tenn.** — Crane Co., 836 S. Michigan Ave., Chicago, Ill., valves, piping, plumbing equipment, etc., plans power house at proposed new titanium processing plant, in vicinity of Nashville. It will comprise a number of large units, with facilities for heavy output. Entire program reported to cost about $25,000,000.

**Abilene, Tex.** — West Texas Utilities Co., Third St., plans expansion in local generating plant, including installation of turbine-generator and accessory equipment, high-pressure boiler and auxiliaries, for increased capacity. Company plans an expenditure of about $4,000,000 for this and other work, including power substations, transmission lines, etc.

**Fort Worth, Tex.** — Texas Electric Service Co., Fort Worth, has arranged for sale of bond and preferred stock issues to total about $17,000,000, proceeds to be used for expansion and improvements in plants and system. As recently noted in these columns, company plans enlargement of local steam-electric generating station, with installation of new 115,000-kw. turbine generator, high-pressure boiler and accessory equipment.

**Galveston, Tex.** — Houston Lighting & Power Co., Galveston District, Houston, Tex., is considering plans for extensions in local steam-electric generating station on 26th St., with installation of new turbine-generator, high-pressure boiler and accessory equipment. Cost reported approximately $3,500,000.

**Houston, Tex.** — Houston Lighting & Power Co., Fannin and Walker Sts., plans expansion in local steam-electric power plant, with installation of new turbine-generator, high-pressure boilers and auxiliary equipment, reported to cost about $4,000,000. Company also is projecting plans for new generating plant, estimated to cost close to $6,500,000 with equipment, including power substations, transmission lines and other operating facilities.

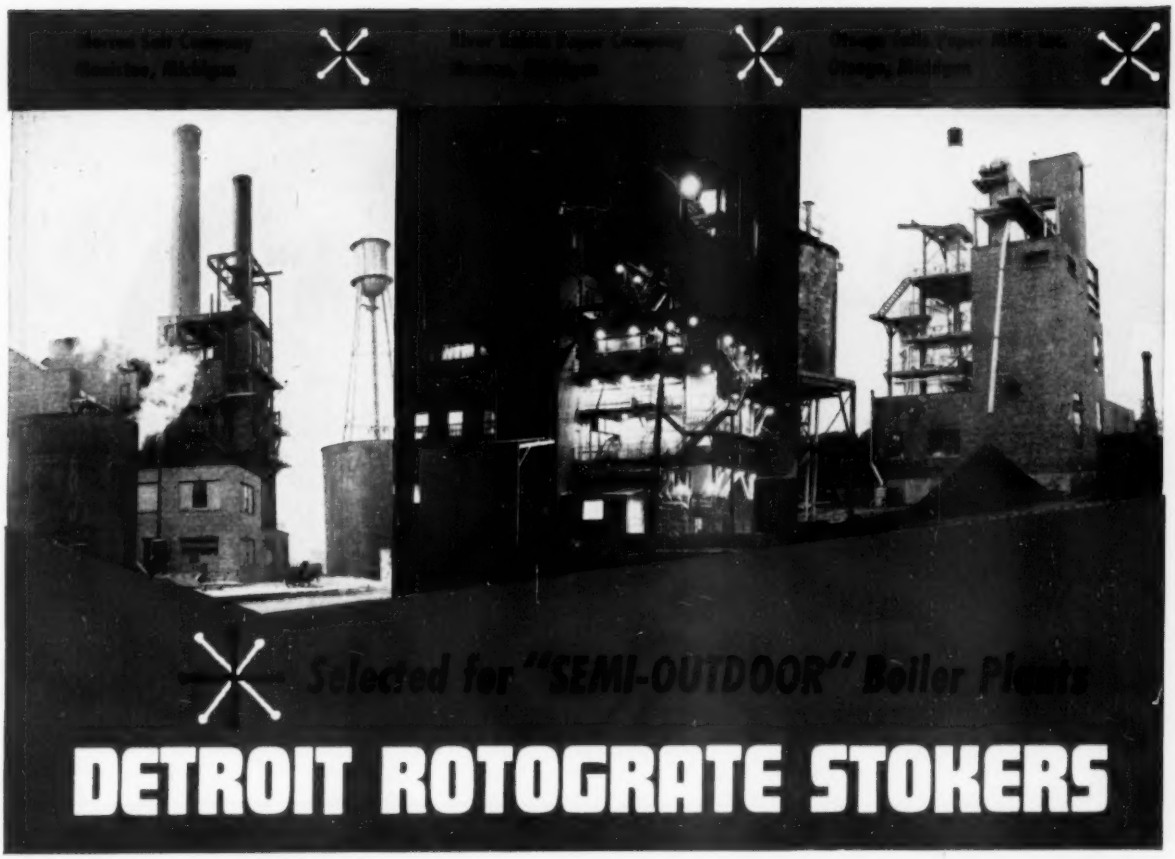
**Houston, Tex.** — Philip Carey Mfg. Co., Lockland, Cincinnati, Ohio, plans power house at new plant near Houston for manufacture of petro-chemical products, roofing and other processed papers, asbestos cement shingles and other building specialties. It will comprise several production buildings and will represent a reported investment of close to $5,000,000.

**Lindale, Tex.** — Town officials have plans maturing for new municipal electric light and power plant in lake area in northern district. Cost reported about $5,700,000, with transmission lines and other facilities. A bond issue in that amount has been approved. J. M. Loyd & Associates, Tyler, Tex., are consulting engineers.

**Port Angeles, Wash.** — Crown-Zellerbach Paper Co. has approved plans for new steam power house at local paper mill, and will proceed with steel frame superstructure this spring. Installation will include one or more boilers and accessory equipment. No estimate of cost announced. Main offices of company, 343 Sansome St., San Francisco, Calif.

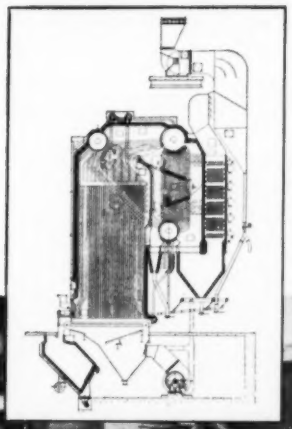
**Prosser, Wash.** — Bureau of Reclamation, Denver, Colo., plans to issue call for bids in June for construction of proposed Chandler hydroelectric generating plant on Yakima River, vicinity of Prosser. Plant will have a rating of 12,000-kw., divided into two 6000-kw. units, with hydraulic turbine and auxiliary equipment. Project will include a turbine-driven pumping station.

**Menasha, Wis.** — City Council is reported planning extensions in municipal light and power plant, with installation of new 7500-kw generator, high-pressure boiler and auxiliary equipment. Estimates of cost are being made. It is understood that program will be carried out early in 1954.



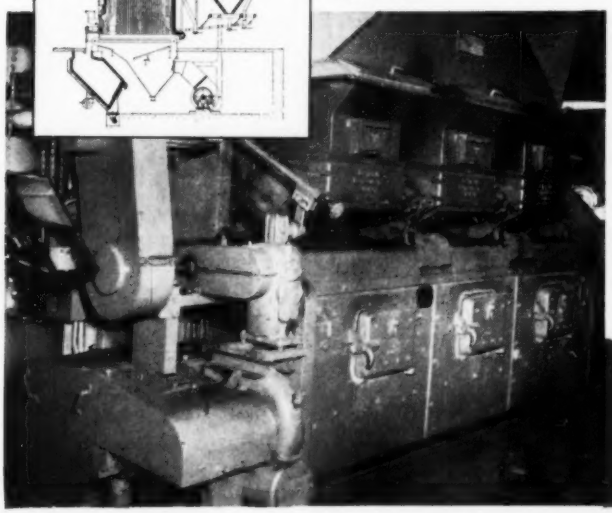
Selected for "SEMI-OUTDOOR" Boiler Plants

# DETROIT ROTOGRATE STOKERS



**AT OTSEGO**

75,000 pound unit with superheater and economizer. 650 pounds pressure 750° F steam temperature. Based on Ohio Strip Mine coal—10,800 BTU.



**Savings in building structure costs are substantial. May run as high as 15% of the total investment in the boiler, stoker and accessories, according to Cummins & Barnard Inc., Consulting Engineers, Ann Arbor, Michigan.**

**Here are representative RotoGrate "semi-outdoor" installations made under the direction of these Engineers.**

## *Detroit RotoGrate Stokers*

- **Provide More Capacity**
- **With High Thermal Efficiency**
- **Readily Applied**
- **Burn Wide Range of Fuel**
- **Exceptionally Dependable**
- **Reduce Steam Costs**
- **Maintenance Low**

***Investigate now.***
***No obligation—write:***

DETROIT STOKERS

**DETROIT STOKER COMPANY**

Works at Detroit, Michigan • Offices in Principal Cities

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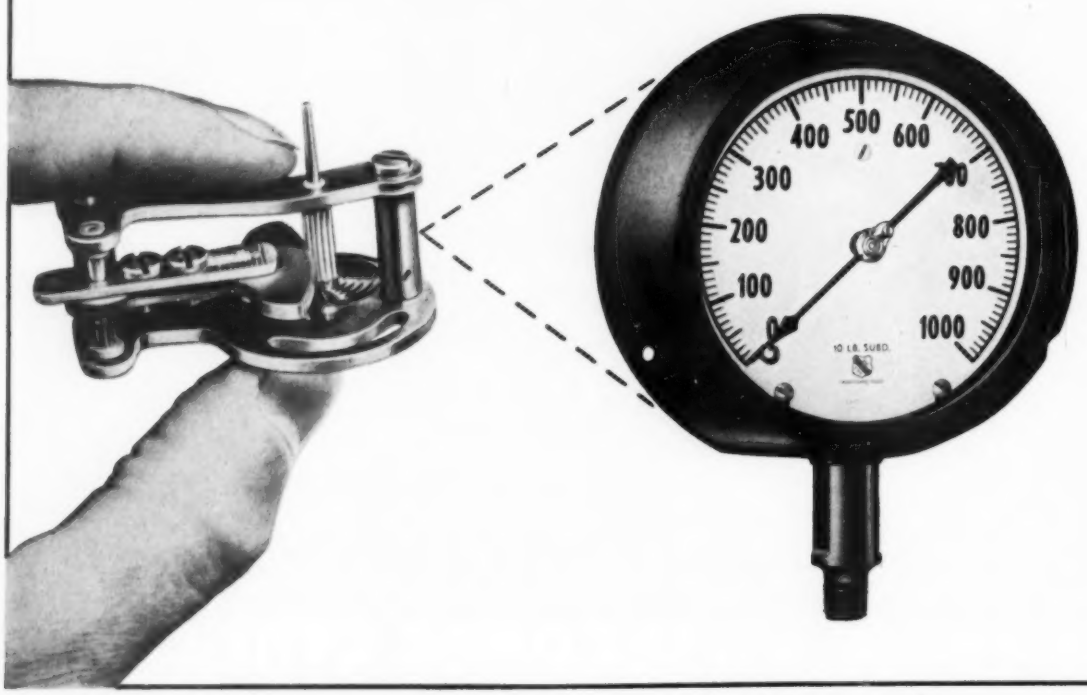
## LASTS FAR LONGER IN ANY SERVICE...




# ASHCROFT DURAGAUGE WITH *Nylon Movement**

Nylon is light, strong, highly resistant to frictional wear. It absorbs vibration and doesn't corrode. It is dimensionally stable under high temperatures. That's why the bearings and pinion gear in the Ashcroft Duragauge movement are made of nylon. Mated with stainless steel parts and incorporating the rotary gear principle used in the finest watches, the result is a pressure gauge that gives longer service, sustained high accuracy and greatly improved sensitivity of indication.

The enduring dependability of precision-built Ashcroft Duragauges with Nylon Movement has been proved in the most "killing" services. Petroleum refineries, chemical plants and power stations know from experience that they *outlast all others.* So — if you want accurate pressure indication or recording to insure maximum safety, product quality, or cost control — install Ashcroft Duragauges. Your nearby Ashcroft Distributor will gladly help you select the proper Duragauges for your applications.

*Patented

**Centralize Your Purchasing.** Take advantage of the simplified buying procedures, low inventory investment and fast delivery service made possible by the facilities of your local Industrial Supply Distributor. Remember, he stocks hundreds of top-quality items and is your most reliable source for data on all that's new in time and money-saving products and methods.

# ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

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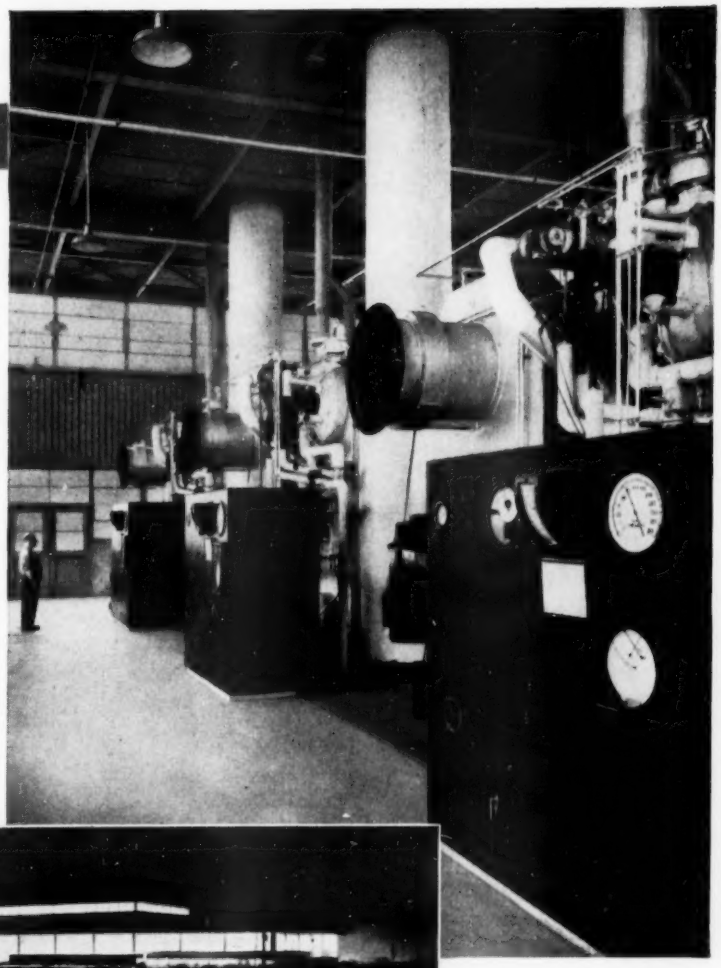
*keeping steam cheap . . .*

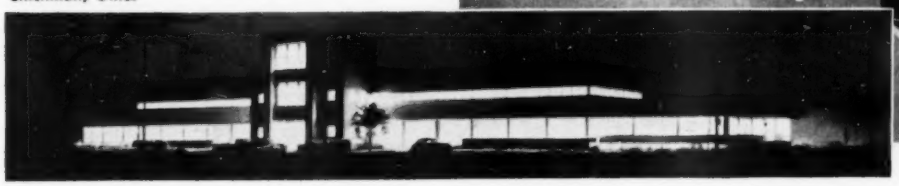
# with a multiple-unit installation

*at*

**WHITE LABORATORIES, INC.**



Night view of new White Laboratories plant—
A. M. Kinney, Inc., Consulting Engineers,
Cincinnati, Ohio.



- Saves Erection Time and Cost
- Meets Wide Range of Service
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and/or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation

Installation of 3 B&W Integral-Furnace Boilers, Type FM, to serve the steam requirements of the large, modern plant of White Laboratories, Inc. at Kenilworth, N. J., is one more indication of the industry-wide acceptance trend now firmly established by these shop-assembled, B&W Units. Choice of this multiple-unit application of FM boilers instead of a single, larger unit, was decided on after careful consideration of all the factors involved in designing this new, expanded plant to provide a solution to White's continuing space problem. Each of these compact, versatile B&W Units is oil-fired by a B&W Y-Jet oil burner equipped with steam atomizer, and each is capable of producing 23,800 lb of steam per hr at pressures to 235 psi.

Combining the benefits of "package" steam with cost-saving big boiler advantages, B&W's Integral-Furnace Boiler, Type FM, has already been selected for a variety of companies covering more than 50 different industries as well as utilities and other users. B&W Units having a total steam capacity of more than 6½ million lb per hr are now in service or on order. Over half of this total capacity consists of multiple-unit installations. Available in standard sizes for loads ranging between 2900 and 28,000 lb per hr at steam pressures between 15 and 235 psi, this self-contained B&W steam generator is also obtainable for operation at higher pressures.

*Send for Bulletin G-76 describing and illustrating the many cost-saving features of this popular boiler. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd St., New York 17, N. Y.*

**BABCOCK & WILCOX**

G-594

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# LEFFEL BOILERS are Ruggedly Beautiful—

## *and you can depend on them*

VAN DYNE-CROTTY COMPANY
2240 RICHARD ST. ★ DAYTON 3, OHIO ★ PHONE: KENMORE 5178

KEX NATIONAL SERVICE

The James Leffel & Company
Springfield, Ohio

Gentlemen: Attention: Mr. A. G. Lebold

At the present time, in our power plant, we have two Leffel Oil Fired Boilers. One is a 100 H.P. unit, the other is a 150 H.P. unit. We have the 100 H.P. Boiler as a standby unit in case of an emergency, and we are happy to say that the operation of the 150 H.P. Boiler has been so successful that we have never had to use the standby.

The 150 H.P. Leffel Boiler is operated five days a week, and at the present time is pulling as high as 270 H.P., with excellent results. Since the time of installation we have had no repairs on this outfit.

We have always considered the LEFFEL Boiler the best that is obtainable.

Yours very truly,

Chas J Kurtz

Chief Engineer
THE VAN DYNE CROTTY CO.

**Bridges, buildings and other load-bearing structures are designed with 100% overload capacity. A boiler should be so designed, too.**

**All the chrome and red paint in the world won't help if you need power above your boiler's rated capacity and can't get it.**

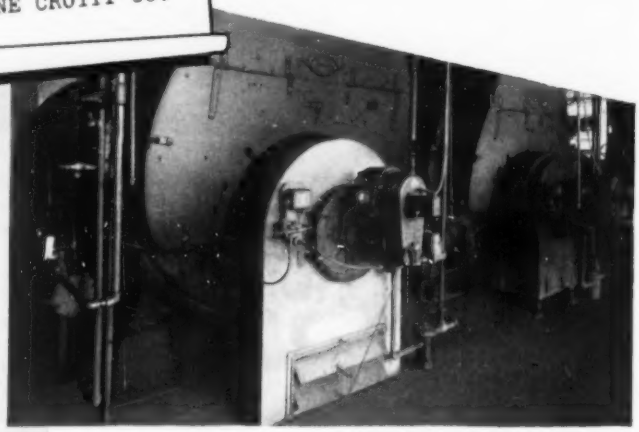
**Streamlined boiler design won't keep your production up if your boiler has a tendency to break down.**

**A boiler rated close to its peak capacity usually has corners trimmed elsewhere. No help in an emergency. Strains to reach rated performance.**

***You can depend on Leffel boilers.*** **Look at the second paragraph in the letter above. Ask about a Leffel boiler wherever you find it. You'll find it's hardly noticed, because it has done its job, and more, however old it is, with a minimum of attention.**

**The integrity of Leffel has never been lowered—*not once*—during the entire 91 years of our history.**

**If you want a boiler you won't worry about, fired by coal, gas or oil, drop us a line.**



The boiler room at Van Dyne-Crotty contains a 150 H. P. Leffel boiler, ***actually*** delivering up to 270 H. P., shown in the foreground—and a 100 H. P. Leffel Scotch boiler next to it.

Sheet 10-30-52

FOUNDED IN 1862

# THE JAMES LEFFEL & CO.

DEPT. A, SPRINGFIELD, OHIO, U. S. A.

MORE EFFICIENT STEAM GENERATION FOR 91 YEARS

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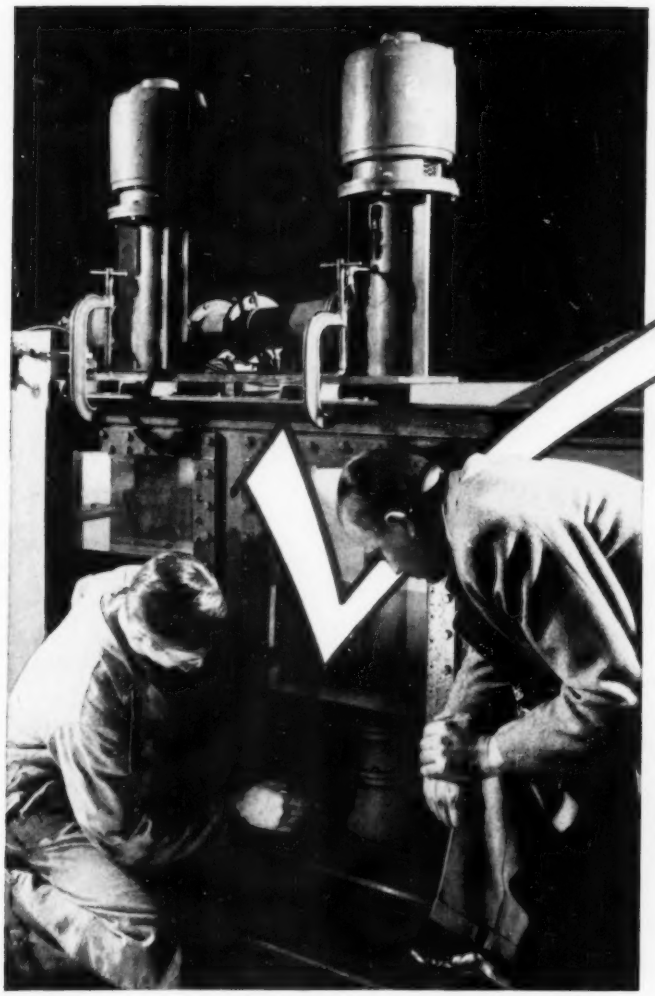

ALLIS-CHALMERS
PUMP
Laboratory

Check

# Suction Bay and Pump Performance in Advance

**Use this Allis-Chalmers pump laboratory to duplicate your suction bay design and operating conditions.**

WHY CHANCE EXPENSIVE BUILDING ALTERATIONS when you can be sure of suction bay and circulating pump performance in advance. In the Allis-Chalmers pump laboratory, an exact scale model of your suction bay can be built. Then you observe the effects of different foundation arrangements . . . can check efficiencies under partial load . . . test the ultimate capacity of your design in case of expansion . . . see what happens under different water conditions. This way you can be sure that you have the right design, down to the last detail.

### Available to Power Plant Operators and Consulting Engineers

The Allis-Chalmers pump laboratory is located at the West Allis, Wisconsin, Works and is available for use for all power plant operators and consulting engineers with large pump and water supply problems. For details of the services available, call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3973

# ALLIS-CHALMERS

A-C ALLIS-CHALMERS

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# "HOW WE USING COAL

Louis G. Natte,
Chief Power Engineer,
Little Falls Laundry,
Little Falls, N. J.

To this great modern plant in Little Falls, N. J., 500 employees come every day to take care of the laundry for an estimated 100,000 people. And from this plant 100 trucks travel to customers spread across a 5,000 square-mile area! The laundry can be called completely self-sufficient. It depends on coal to provide all electric power and lights—heat for all buildings—steam for hydraulically-operated machines—steam for pressers and dryers.

**If you're running your own steam plant, here are a few down-to-earth facts you don't want to miss!**

**COAL** in most places, is today's most economical fuel.

**COAL** resources in America are adequate for all needs—*for hundreds of years to come.*

**COAL** production in the U.S.A. is highly mechanized and by far the most efficient in the world.

**COAL** prices will therefore remain the most stable of all fuels.

**COAL** is the safest fuel to store and use.

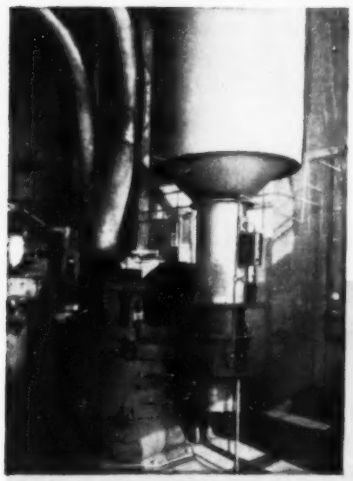
**COAL** is the fuel that American industry can count on more and more—for with modern combustion-and-handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

*FOR HIGH EFFICIENCY*
*FOR LOW COST*

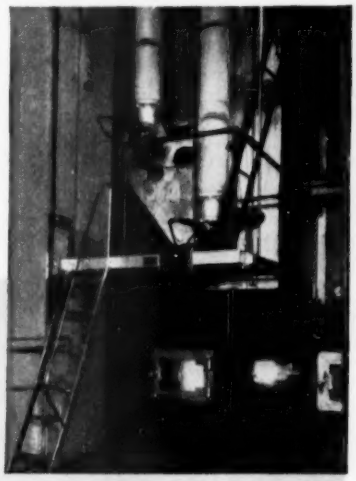
# SAVE $20,000 A YEAR—INSTEAD OF OIL"

**(ACTUAL CASE HISTORY OF THE LITTLE FALLS LAUNDRY, LITTLE FALLS, N.J.)**

**"Our laundry is one of the largest in the country," says Chief Power Plant Engineer Notte, "and, we think, one of the most progressive. Our company insists on superior performance at lowest possible cost all along the line. That's exactly why we depend on coal-fired equipment. From coal we get the daily amount of BTU's we need at a cost of $200—to get the same BTU's from oil would cost $280. We can change to oil on less than a day's notice —but so far we've *never* done it. Coal does a great job—cheaper."**



This is the company's up-to-date pulverizer from which the ground coal is blown into the boiler. Before this final operation, the laundry employs a steel-slatted conveyor belt to feed a precrusher. From there, power-driven bucket-conveyors carry the coal to the 100-ton storage hopper which feeds the pulverizer. *Modern automatic coal devices of all kinds slash labor costs—make coal's basic economy even greater.*



**This is a section of the laundry's modern coal-fired boiler installation. With modern equipment like this it is possible to add anywhere from 10% to 40% to the power derived from the same amount of coal in years past. Actually with coal-fired plants of up-to-date design many companies have brought over-all boiler efficiency up to 85% or more.**

● Plants that use coal are in an enviable position —at the present *and* for the future. *For they are more certain than the users of other fuels of a dependable fuel supply—at stable prices.* The reasons are compelling. Of America's total fuel reserves, 92% is coal: Even today, oil is *imported* while this country can and does *export* coal. In addition—this country's mines are the most highly mechanized and efficient in the world.

To get *all* the great economy that coal can deliver—to find out how much more efficient and dependable a job coal and the very latest coal-fired equipment can do—call in a competent consulting engineer. He'll recommend the right equipment for your specific needs. Then you'll see exactly why coal *on a performance basis, on a dollars-and-cents basis* . . . is your best fuel buy, by far!

**BITUMINOUS COAL INSTITUTE**
A DEPARTMENT OF NATIONAL COAL ASSOCIATION
**WASHINGTON, D. C.**

***YOU CAN COUNT ON COAL!***

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# Call your shots

Specify **SCOVILL** PHOSPHORIZED

**ADMIRALTY HEAT EXCHANGER TUBES**

When you are up against tough operating conditions affecting heat exchanger tubes...relax. Accept our invitation to let Scovill engineers help work out the right tube specification. Then go ahead and call your shots on performance.

Any one of Scovill's popular heat exchanger tube alloys will prove best in its class for specified service conditions. Most popular of them all is our Phosphorized Admiralty Tube . . . *in a class by itself* because it is hot extruded from CONTINUOUS-CAST billets. Scovill Continuous Casting of this alloy assures highest standards of SOUNDNESS and UNIFORMITY, and optimum amount of inhibitor (Phosphorus) for maximum resistance to dezincification. Tube troubles literally find no "foothold" in uniformly protected and finished tube surfaces.

Our informative 40-page heat exchanger tube technical booklet will be sent on request. Inquiry outlining your problems and needs is welcomed. Write Scovill Manufacturing Company, 99 Mill Street, Waterbury 20, Conn. Phone Waterbury 4-1171.

**SCOVILL**
**HEAT EXCHANGER TUBE ALLOYS**

- PHOSPHORIZED ADMIRALTY
- ADMIRALTY
- ARSENICAL ADMIRALTY
- MUNTZ METAL
- NAVAL BRASS
- RED BRASS, 85%
- DEOXIDIZED COPPER
- ARSENICAL COPPER
- COPPER NICKEL, 10% & 20%
- CUPRO-NICKEL, 30%
- CUPRO-NICKEL, 30% (High Iron)
- ALUMINUM BRASS
- ALUMINUM BRONZE, 5%
- DUPLEX TUBE

SCOVILL

*"You can't buy better Brass"*

9SC53

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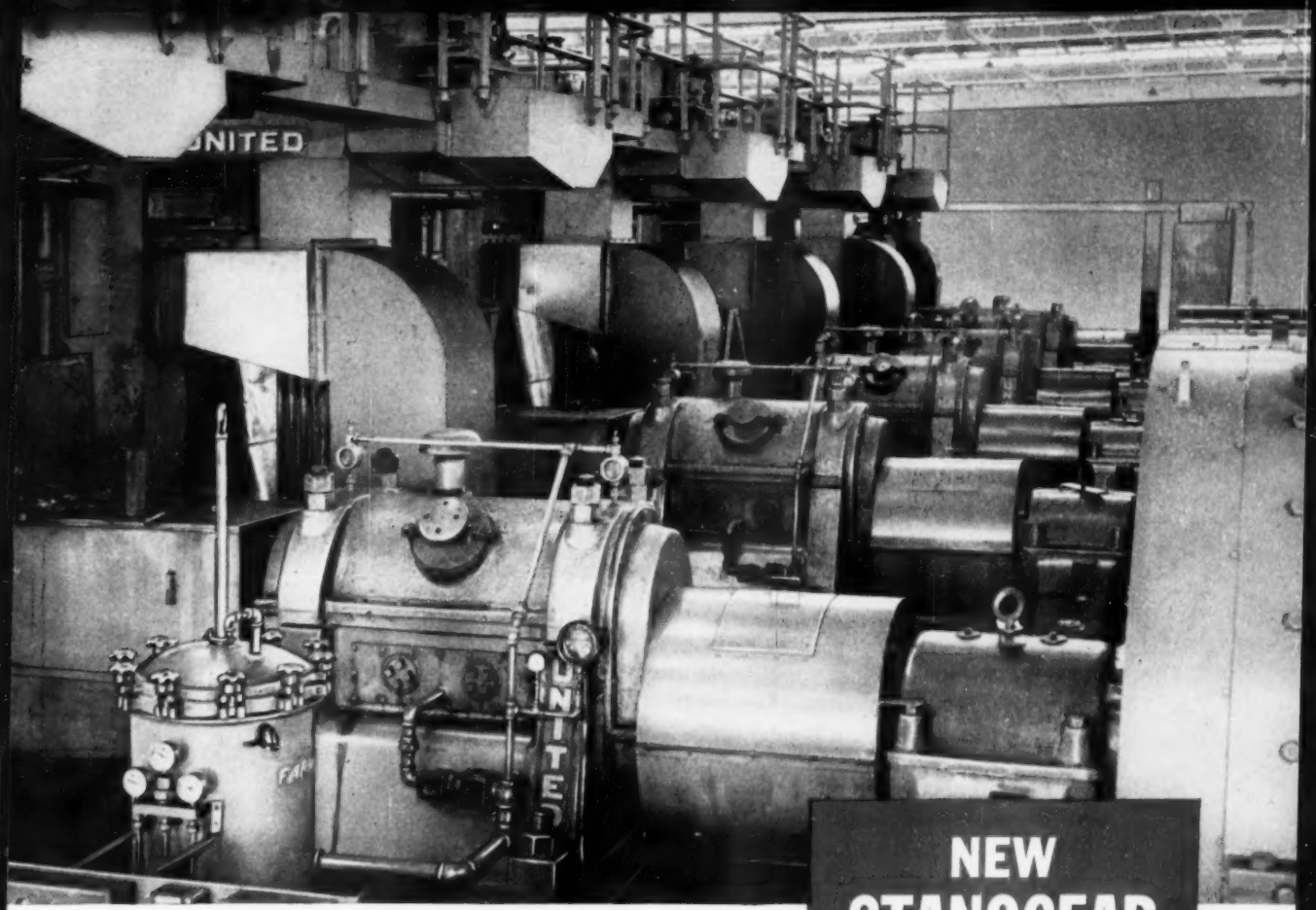



# NEW STANOGEAR
REG. U. S. PAT. OFF.
## Compounds

## NOW . . . 7 ways better for extreme-pressure lubrication . . .

New and improved STANOGEAR Compounds have been developed to meet the requirements of an increasing variety of tougher extreme-pressure lubricating jobs found throughout industry, today. The result of several years of special research and field test work, these outstanding products have proved in actual service their ability to provide these important advantages:

**1. Higher load carrying capacity.** Use of improved extreme-pressure additives in STANOGEAR Compounds provide a greater anti-weld property. This results in the higher load carrying capacity which these products have demonstrated in actual service.

**2. Superior retention of load carrying capacity.** In service tests, STANOGEAR Compounds have proved superior to conventional extreme-pressure lubricants in ability to maintain a high load carrying capacity over extended periods of service.

**3. Freedom from objectionable deposits.** Appropriate base stocks and additives give STANOGEAR Compounds a high resistance to oxidation, thus minimize the formation of deposits.

**4. Excellent storage stability.** STANOGEAR Compounds contain compounding ingredients which assure excellent stability both in service and storage.

**5. Good water separation.** STANOGEAR Compounds have demonstrated their superiority to ordinary extreme-pressure lubricants in ability to provide good water separation.

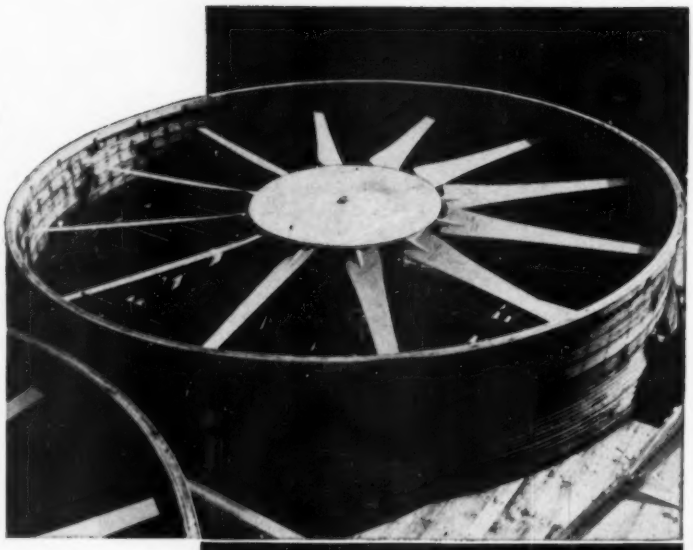
**6. Anti-foaming.** Under adverse operating conditions, the anti-foam agent in STANOGEAR Compounds has prevented foaming troubles.

**7. Versatility.** A unique combination of additives in STANOGEAR Compounds equips these products for various industrial gear applications where extreme-pressure lubricating properties are necessary. To meet varying viscosity requirements, STANOGEAR Compounds are available in eight viscosity grades.

The Standard lubrication specialist in your area of the Midwest will be glad to give you more information about the new STANOGEAR Compounds. You need only phone your local Standard Oil office. Or write: Standard Oil Co., 910 South Michigan Avenue, Chicago 80, Illinois

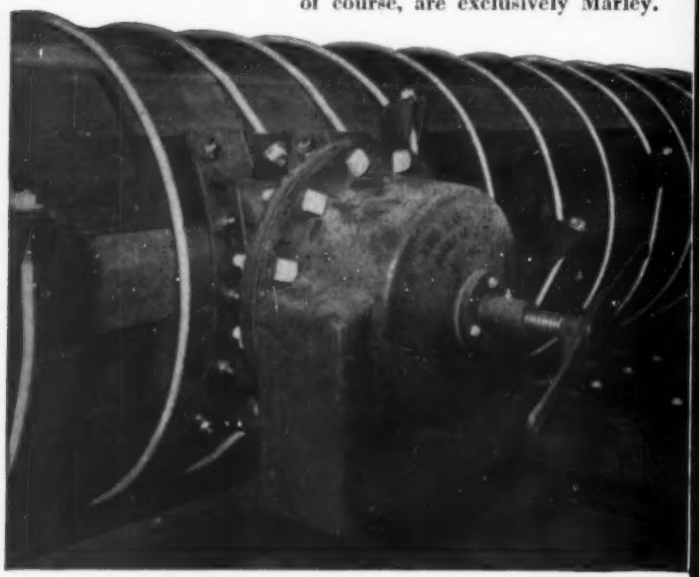
**STANDARD OIL COMPANY** STANDARD *(Indiana)*

# exclusive Marley features that mean PERMANENT PERFORMANCE



Improvement of performance and service life of the vital elements of cooling towers is a continuing project of Marley research and engineering. The results of this effort set the pace for the entire industry.

Here are four advanced features that are incorporated into current Marley production.* They are distinct achievements in cooling tower design, and, of course, are exclusively Marley.



*Any cooling tower can be modernized with Marley design features.

**Marley Multi-Blade Fans –**

These fans are aerodynamically correct in design to move air in volume efficiently. Their further accomplishment is to remove pulsation with its damaging vibration.

**Marley Patented Laminated Fan Cylinders –**

Built of multiple plies of redwood, the Laminated Fan Cylinder is completely non-corrosive and vibration resistant. Field service proves its permanence.

**Marley Redwood Pipe –**

This header pipe is carefully prefabricated in Marley's wood fabrication plant for cooling towers (largest in the world). Its perfect fit and strong, adjustable steel bands on close centers assure its long life. On the job it is erected easily, quickly.

**Marley Flow Control Valve –**

Marley flow control valves insure equal distribution of water to each cell and effectively handle any quantity of water from full basin capacity to complete shut-down.

*Ask your Marley Sales Engineer (in fifty cities) for detailed information about these achievements that have maintained Marley leadership.*

MARLEY

**The Marley Company**

Kansas City, Missouri

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**NO GETTING AROUND IT!**

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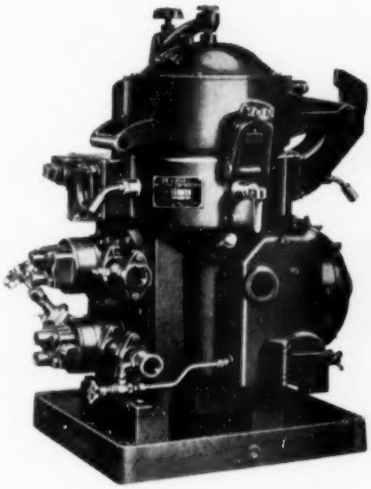

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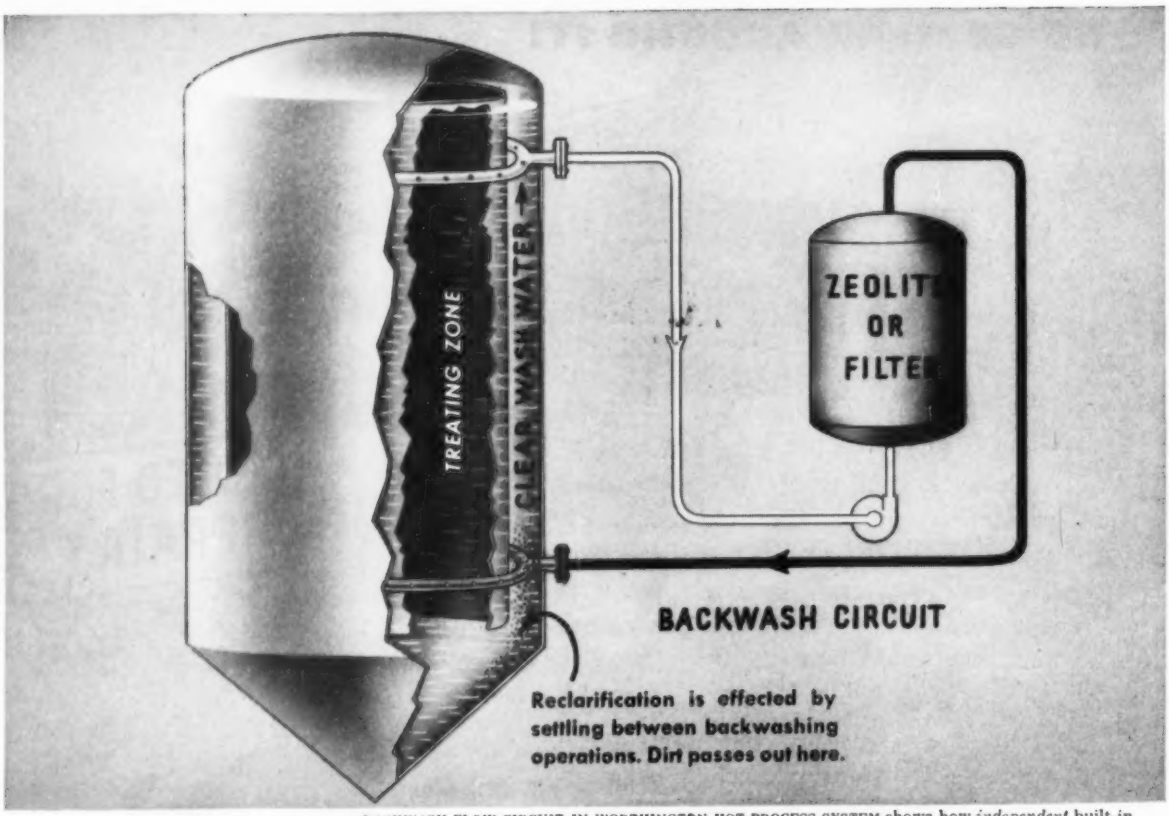


BACKWASH FLOW CIRCUIT IN WORTHINGTON HOT-PROCESS SYSTEM shows how *independent* built-in, annular wash-water compartment* provides clean, hot, chemically inert water for backwashing and reclaims it without affecting operating velocities in treating zone, or subjecting hot zeolite to temperature changes. Backwashing is accomplished by recirculation of the clarified wash water.

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## *How Worthington Hot-Process Water-treating systems backwash with CLEAN, hot, chemically inert water*

When you're considering hot-process water-treating systems with hot zeolite, filters, or both, *don't overlook backwashing facilities.*

They must be well designed, or the system cannot give smooth, efficient, trouble-free performance. Worthington engineers recognized this fact when they designed their first hot-process system. Today, every Worthington standard Hot-Z or conventional system provides exclusive *independent* facilities for backwashing zeolite or filters with clean, hot, chemically inert water without disturbing the normal flow through the reaction bank.

*Worthington water-treating specialists don't believe you can wash clean with dirty water.*

This unique backwashing provision is just one of many Worthington patented features, but it alone will more than justify your selection of a Worthington system for hot-processing boiler feedwater in your plant.

If you have a problem, whether it involves filtration, precipitation, or zeolite treatment, Worthington specialists will be happy to study your water-treating problem and recommend the proper system. Just write, stating service conditions in detail, to Worthington Corporation, Water Treating Division, Harrison, N. J. J.2.1

Worthington Makes More of the Equipment for ALL Types of Water Conditioning Systems

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Water Conditioning

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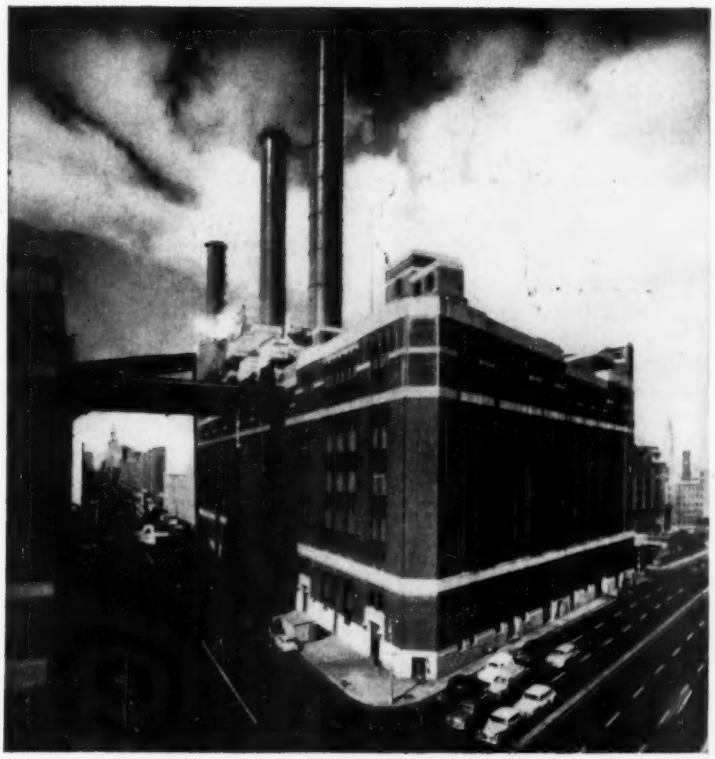
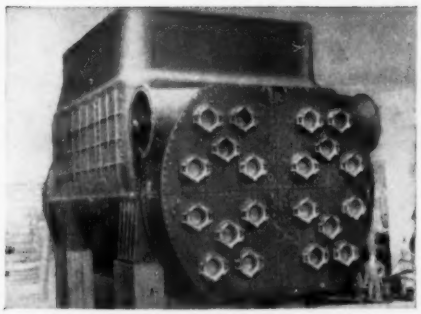
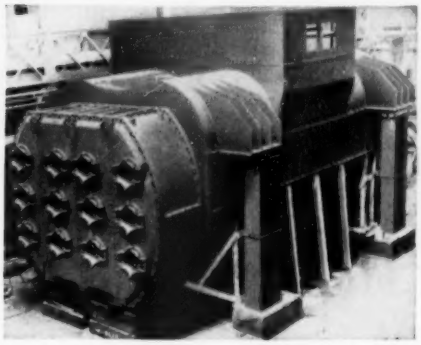


CON EDISON'S EAST RIVER ELECTRIC GENERATING STATION at 14th Street, New York City, will contain the new Worthington 125,000 sq-ft condenser. The shell, which is to be installed under 160,000-kw Unit No. 7, will contain nearly 105 miles of ¾" O.D. aluminum brass tubes and will require 138,000 gpm of East River water supplied by two 54 in. Worthington "Mixflo" vertical single suction volute circulating pumps.



WORTHINGTON CONDENSER installed in 1931 to serve 160,000-kw Unit No. 7, Hudson Avenue Station. Tube sheets were drilled for 110,000 sq ft with 101,000 sq ft installed.



ONE OF TWO 74,500 SQ-FT 2-PASS WORTHINGTON CONDENSERS serving 60,000-kw Units 14 and 15 at Waterside Station No. 1.

# Con Edison once again installs "largest" condenser

On several occasions over the past fifty years, Worthington has been selected to build the "world's largest" surface condensers in single shell design.

In 1919, a 70,000 sq-ft condenser was installed under a 35,000-kw turbine-generator for a prominent utility company. This was the largest single shell surface condenser of its day.

In 1931, Brooklyn Edison Company (now Consolidated Edison Company of New York, Inc.) installed, under 160,000-kw Unit No. 7 at the Hudson Avenue Station, the "world's largest" at that time, a 101,000 sq-ft single-pass Worthington condenser. This was followed, in 1949, by two 74,500 sq-ft condensers for Waterside Station No. 1.

Now, Worthington is again building for Con Edison the "world's largest" single-shell condenser ever ordered, 125,000 sq-ft, single-pass, for the 160,000-kw Unit No. 7 addition to East River Station.

Worthington, with over a century of experience in the manufacture of steam power equipment, is prepared to build efficient condensers in all sizes. Let us advise you, without obligation, on your new installation.

Write, stating requirements, to *Worthington Corporation, Steam Power Division, Harrison, New Jersey.*

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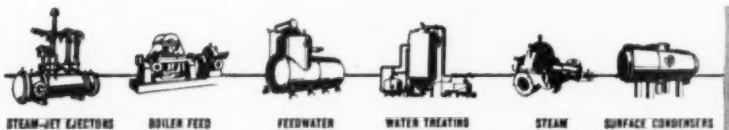


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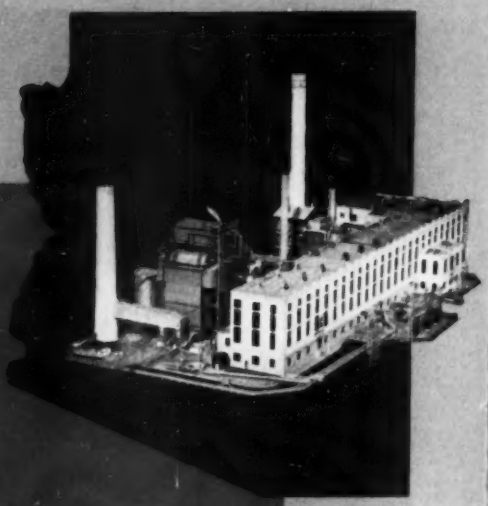

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Such popularity had to be won. It was—by offering good design, careful engineering and manufacturing, modern metallurgy and dependable service.

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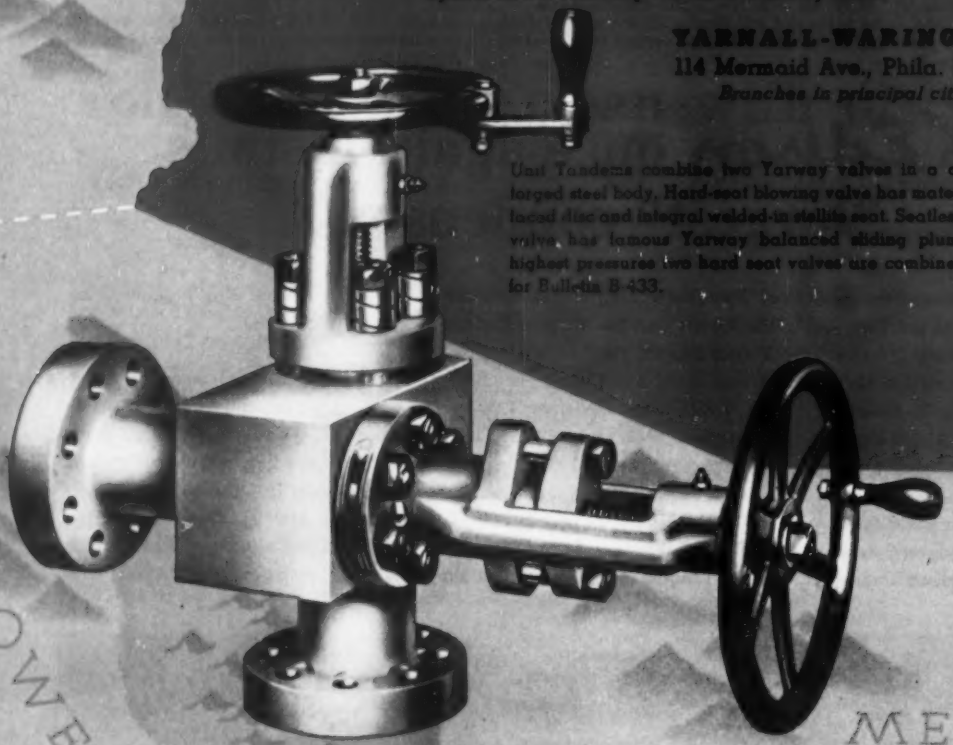
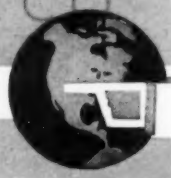


Unit Tandems combine two Yarway valves in a one-piece forged steel body. Hard-seat blowing valve has mated stellite-faced disc and integral welded-in stellite seat. Seatless sealing valve has famous Yarway balanced sliding plunger. For highest pressures two hard seat valves are combined. Write for Bulletin B-433.



***YARWAY SERVICE GOES ALL THE WAY....***

**How an Editor Played a Vital Role in the Period Since Hiroshima When Research Worked to Prove—**

# Atomic Power Just Around the Corner

**By RICHARD H. MORRIS, Editorial Director**

EIGHT YEARS AGO the President announced the successful atomic bomb drop on Hiroshima. This told a startled world that the problem of nuclear fission had been solved—and the end of the war not far away.

Late in May the Atomic Energy Commission released the Industrial Report on Power Reactors. This told an impatient world that the application of nuclear fission to industrial use had been solved — and atomic power not far away.

Hundreds of editors will reprint all or portions of the report which is readily available in complete form from the Government Printing Office. Thousands of pseudo-experts will interpret it. An equal number of imaginative artists will draw fantastic illustrations. In this highly specialized field, not fully explored, filled with technical jargon and hedged in by rigid security, few know the real story and still fewer can tell it.

One of these very few is Andy Kramer. He prepared the AEC reactor release. He is a member of the Advisory Committee with top security clearance. He has visited and studied at first hand the work at AEC Laboratories and contractor sites. He has discussed nuclear physics with scientists, as an equal and in scientific terms.

As an experienced editor he has the rare ability to translate scientific language into engineering terms and project laboratory work into practical accomplishments. As an experienced power engineer, he knows what the work in the reports means to industry, and how close atomic power is to being a commercial reality.

The report shows that atomic power is practical, commercially sound and feasible. A start on construction is contingent only on security and legislative restrictions which are not insurmountable. A detailed abstract of the report would add little to engineering knowledge because the complete report is readily available to everyone.

Instead Kramer has, in the following pages of this special section, drawn upon his unique background and experience to give an original explanation and interpretation of the report and the work. Because of his familiarity with the unclassified version as well as with the original classified material he has been able to write a report that does not duplicate the official document but will help to understand the significance of the full report.

Kramer's lifelong interest in the scientific and practical aspects of nuclear energy was kindled by amateur radio in the old spark days long before World War I. A series of articles, started in 1926, were later collected in book form, the first of several of his books to be published. Since the end of World War II he has been in demand as a speaker before military, engineering and non-engineering groups across the country.

As early as 1935 he made drawings outlining an atomic power plant. As the field developed from the first carbon pile at the University of Chicago to the atomic explosions over Japan, he followed the work closely. After the President's announcement, Kramer wrote a series of articles explaining the development work on the atomic bomb. This was the start of the magazine ATOMICS, first published as a section in the magazine for five years.

In 1946 he received an appointment to attend the Atomic Bomb Tests at Bikini. These tests he reported in a series of dispatches direct from the scene. In 1947 he was invited to Oak Ridge National Laboratory for the Heat Transfer Conference, to study the problems of heat transfer in relation to the development of nuclear reactors.

In 1952 he was appointed a member of the Advisory Committee on Industrial Information to the AEC, a group of experts formed to examine the work at AEC sites, identify information of value to industry, and advise on declassification.

Last fall, as a member of the committee, he was appointed as one of a two man task force (with S. A. Tucker, publications manager, ASME). In this assignment, they reviewed the work and voluminous reports of the four groups of companies engaged in the development of atomic power plants, and prepared an unclassified summary for release to industry.

This work had hardly been completed when he was delegated to go to Hanford and Arco, investigate the reactors at these two sites, and recommend for declassification of reactor data and material which would be of value to industry.

**ABOUT THE AUTHOR** — Andrew Kramer, noted industrial editor and long recognized as an authority in the field of nuclear physics. Because of this dual experience he was appointed power industry representative on the AEC Advisory Committee. In this capacity and as one of a team of two, he reviewed the voluminous research reports and prepared the versions just released by the AEC. At present he is in the Northwest with another small AEC task force reviewing the work at Hanford and Arco to consider possible declassification of reactor data. In addition to his AEC activities, Andy is editor of POWER ENGINEERING, the first editor of ATOMICS and consulting electrical editor of PLANT ENGINEERING.

# Basic Facts

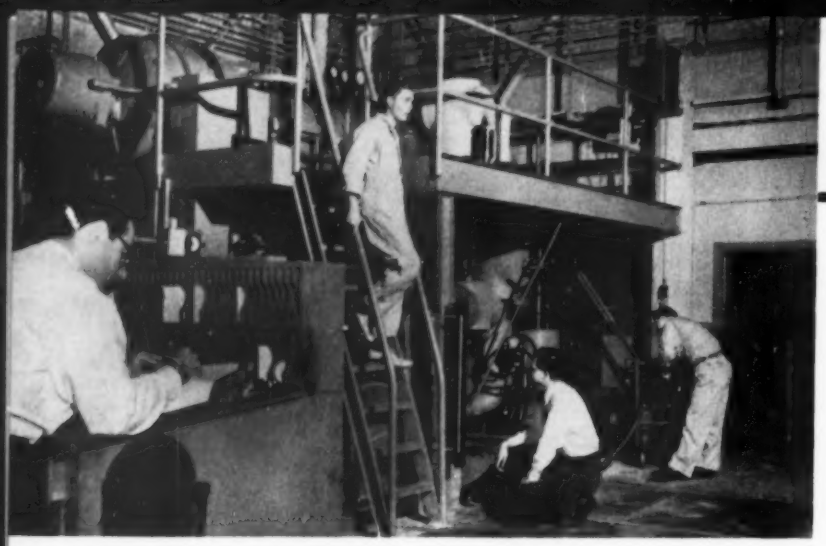


**Fig. 1. View of the electric power equipment associated with the new liquid-fuel nuclear reactor at Oak Ridge National Laboratory. This reactor successfully produced electric power late in February**

SINCE that historic summer day, early in August 1945, when the news of the first atomic bomb explosion over Hiroshima swept around the world, people in all countries have regarded the advent of atomic energy with mixed apprehension and enthusiasm. For like many other human achievements, nuclear energy has two faces, one good, the other evil.

We know the evil. At Hiroshima, in one blinding, searing flash of light, in one scorching wave of heat, in one terrific surge of blast—in one silent, sinister, sensationless burst of radiation, between 70,000 and 80,000 human lives were snuffed out. That one bomb killed three times as many people as all the air raids on London during World War II. So there is no question about the evil face of nuclear energy.

The good face of nuclear energy has been slower in revealing itself, yet from the beginning most everybody has known it was there. The story goes back a long way—some 25 centuries in fact, to when Democritus in ancient Greece first propounded the idea that all matter is made of minute, finite particles. They were, in his native Greek tongue, *a-tomas: not cuttable.* Thus, the name atom was born, and thus, the story of atomic energy begins, not at Cambridge or Chicago, or Hiroshima, but in Greece, five centuries before the dawn of Christianity.

From that point—from Democritus' inspired arguments to the explosion of the atom bomb over Hiroshima is a long road, a fascinating highway marked with great names—Bacon, Newton, Dalton, Roentgen, Curie, Einstein, and others; a highway with an ever broadening horizon but beset with obstacles, blind sideroads and confusing detours, but one which dogged persistence and infinite skill and patience successfully negotiated. It was in January 1939 that the scientific world was startled by a "letter to the Editor" in *Nature* by Lise Meitner and Otto Frisch announcing the achievement of nuclear fission.

Nuclear fission is a high sounding term but to the layman it means simply splitting the atom. Now, the atom had been split before January 1939, many times in fact but always through the application of far greater energies than was released. The startling thing about the Meitner-Frisch announcement was that the fission of uranium was accomplished by the capture of neutrons, not by the brute-force bombardment by high energy charged particles, as had been the method in all previous experimental work. As Dr. J. G. Feinberg says, everybody talks about the atom, yet it is the neutron which is the real hero—or villain, depending upon how you look at it.

### What Is a Reactor?

The neutron made possible the chain reaction which scientists had been searching for. The principle was simple. When an atom of uranium captures a neutron, it splits, releasing enormous energy, and at the same time one or more neutrons are ejected. These released neutrons are capable of splitting other uranium atoms, and so a chain reaction is set up. If the chain reaction is fast enough, and uncontrolled, we have the atomic bomb. If it is controlled by slowing up the neutrons between each fission, we have a nuclear reactor.

A nuclear reactor is a machine for converting nuclear energy into heat energy that can be used for useful purposes. The first nuclear reactor ever built went into operation on December 2, 1942 at the University of Chicago. It operated at a rate of ½ watt—a small but safe beginning. Later, on December 12 the intensity was run up to 200 watts. Today, reactors operate at thousands of kilowatts.

Basically reactors are not complicated. Practically they are large, expensive gadgets. Their construction and operation involve enormous difficulties. Well then, if they are so troublesome, why build them at all? A fair question.

Reactors can be used for several purposes. Basically, all reactors produce three things—neutrons, fission products, and heat. You can use the neutrons for creating new materials. By a process of transmutation of elements the neutrons can be used in the reactor to produce new and valuable materials such as plutonium for atomic bombs. So the neutrons themselves have cash value. The large amounts of heat generated in a reactor may, or may not, have cash value, depending on how efficiently we can extract it.

The best known examples of reactors utilizing neutrons for transmutation are the Hanford reactors in the State of Washington. These are production reactors, used for making plutonium for our atomic bomb stockpile. Of course large quantities of heat are also generated, but the temperature is so low that the heat cannot be used practically. Its removal is strictly a cooling operation; it is dumped into the Columbia River.

It is obvious, however, that if we could run the temperature of these Hanford reactors up somewhat, and begin to extract the heat at a temperature level enabling us to generate steam and then mechanical or electrical power, it is conceivable that we might get a by-product credit for the power.

Now, plutonium is itself a nuclear fuel. It splits by neutron capture just as does uranium 235. Since more than one neutron is released in each fission, it is conceivable that a reactor producing heat for power could, at the same time, produce as

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**Write the Editor on your company letterhead for a copy. Copies will be sent free as long as they last. Copies are also available from the Supt. of Documents, Gov't Printing Off., Washington 25, D. C., at 25 cents each. The title is "Report to U.S. Atomic Energy Commission on Nuclear Power Reactor Technology."**

# About Industrial Power Reactors

**To evaluate the Reports on Power Reactor Feasibility just released to The Atomic Energy Commission it is necessary that engineers have at least an elementary knowledge of nuclear reactor principles. This brief discussion gives them these basic facts together with some of the history back of the reports**

By ANDREW W. KRAMER

much or even more new fissionable material than we *burn*. This is called *breeding*.

There is nothing *perpetual motion* about breeding. We are merely converting non-fissionable material (U-238) into fissionable plutonium.[1] Consider the case shown in Fig. 2. This shows the process of breeding using *plutonium* as fuel. The number of neutrons emitted per fission

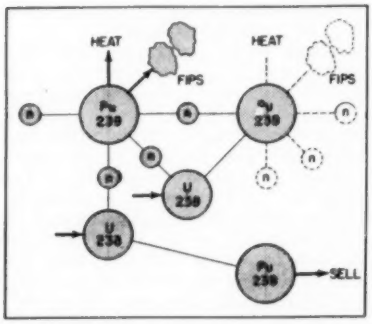


**Fig. 2. Diagram of the fission of plutonium showing the principle of breeding**

of plutonium has been released by the AEC, and is given as 3.0 ± 0.1.

Thus, the number of neutrons which are spent per fission can be added up as follows:

1 neutron to keep up the chain reaction and cause fission.
1 neutron to transmute a fertile U-238 atom to Pu-239 to replace the fissionable Pu-239 atom just burned
X neutrons which go to parasitic, structural and leakage losses

---

2 + X Total neutrons spent in fission

Thus, the net number of neutrons per fission of plutonium 239 is about 3-2-X, or 1-X neutrons per fission available to transmute additional U-238 to Pu-239, which we may extract from the system and sell. The salable plutonium can be used to provide the initial charge for new stationary or mobile power plants or for nuclear weapons.

It is not feasible, here, to discuss the technical and economic problems involved in breeding, which center around making X as small as possible, but there is good reason to believe that breeding is possible. Much research and development has been expended in that direction.

It should be quite obvious that if X is greater than unity, then breeding is not possible, and part of the U-238 must be left behind unburned. If, on the other hand, the losses X can be kept much less than 1, and near 0, then we can show that

1 gm Pu-239 + 2 gm U-238 = 1 $kw_e$-yr + 2 gm Pu-239 (of which only 1 gm is excess and salable) + 1 gm fips (fission products)

or, cancelling

2 gm U-238 = 1 $kw_e$-yr + 1 gm Pu-239 (excess and salable) + 1 gm fips

In this equation the kilowatt-year of electricity ($kw_e$-yr) is based on about 36% thermal efficiency.

*This is the fundamental equation for the nuclear power business.* It is illustrated schematically in Fig. 3. At $35 per pound the two grams of U-238 burned after converting to fuel would cost a negligible fifteen cents. The kw-yr of electricity is worth $44 at 5 mils per kwhr. The gram of plutonium which we might sell is today certainly worth more than $20 to $40, and is ultimately probably worth somewhere around $20 to $40 for a very long term.[2] This significant additional revenue is a second economic advantage for the breeder type of reactor. The two revenues per kw of capacity per year determine how much we can spend for plant investment and operating costs. For an oversimplification, by equating the revenue from plutonium to the operating costs and capitalizing the fuel savings one can arrive at a number between $200 and $300 as permissible investment for the reactor and all its appurtenances up to the steam throttle valve.

As already mentioned, if X is greater than unity, breeding is not possible. If, for example, X is 1.2, than 0.8 atoms of Pu-239 are manufactured for each one burned. It is relatively simple to show that in this case 4 times as much of the more abundant U-238 can be burned, as we have U-235 or Pu-239 to start out with. This more modest but not negligible achievement, considering the World's uranium resources, would give us an energy resource almost equal to the known coal reserves. In view of the tremendous advantage of breeding it is not strange that at least one public utility and chemical plant group is, as John Menke,[2] put it, "headed for breeding or bust."

In view of these facts and other available data on reactor technology it is quite understandable that elec-

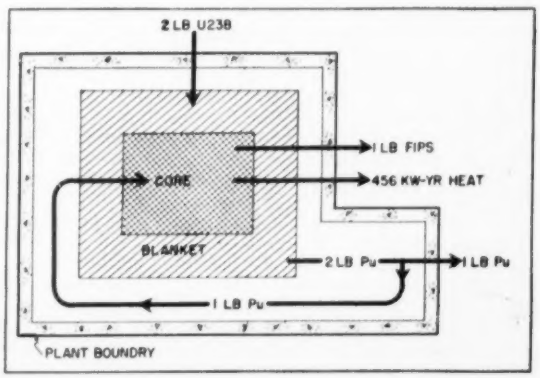


**Fig. 3. This diagram of a breeder reactor shows how 2 lb of non-fissionable uranium is converted into 465 kw-yr of heat and 1 lb of fissionable plutonium**

[1] Only a very small proportion of natural uranium is fissionable. Natural uranium consists of 97.3 per cent U-238 and 0.7 per cent U-235. Only the seven tenths of one per cent U-235 is fissionable. The U-238 can, however, be converted to Plutonium (Pu-239) by neutron absorption, and the resulting (Pu-239) is fissionable.

[2] The calculations and estimates here given together with the illustrations Figs. 2, 3, and 4, are based on a conference paper presented at the 1953 Winter Meeting of the AIEE, by John R. Menke, President, Nuclear Development Associates, Inc., White Plains, N. Y.

tric utility as well as chemical companies should have exhibited an active interest in developing nuclear power plants almost from the beginning. Despite the fact that present legal restrictions prevent private organizations from possessing uranium, several groups of public utility and chemical companies have been engaged in studying and working out the practical and economic elements of atomic power plants, for a number of years. To aid in this work, selected engineers and scientists of these companies were given the opportunity to study classified material and were given training courses at several of the National Laboratories, where they had access to basic classified data underlying the work of the Reactor Division of the AEC. Each group, therefore, approached the problem with the same basic understanding in the light of their specific knowledge and imagination.

Early last fall these four groups of companies completed their preliminary designs and issued reports on their work to the Atomic Energy Commission. These reports are of necessity highly classified since they involve data on reactor technology and fissionable material production of value to potential enemies.

It was also true that these reports contained a great deal of information not of a classified nature that would be of immense value to power engineers and engineers generally.

Early last December, therefore, the Advisory Committee on Industrial Information of the Atomic Energy Commission appointed a small sub-committee to make a detailed study of the reports of the four groups of companies with the object of recommending portions of these reports for declassification and subsequent release to industry. Accordingly, such a study was carried out in late December 1952 and January 1953, and the sub-committee's report was submitted to the Atomic Energy Commission in February of this year. This declassified version has now been released in the form of a printed book. Since even the declassified version is far too long and detailed to present in a monthly publication, we present herewith a general description of the four reports so that readers may determine whether or not they are interested in the complete reports which are readily available from the Government Printing Office at Washington, or from us as explained in the notices on these pages.

The significant feature about these four studies is the almost complete divergence in the methods of attacking and solving the problem of nuclear power development. All groups, of course, had the same objective; the development of systems and methods for the economical production of power from the heat produced in nuclear reactors, yet all four groups came up with significantly different solutions. The first three reports as listed above describe specific designs involving considerable constructional detail. The last report, that of the Detroit Edison-Dow Chemical Co. considers the problem in general and economic terms, all of which are of extreme interest, but it does not attempt to outline specific plant designs.

### Value to Industry

The value-to-industry elements in these reports lies not in the detail of reactor design or construction, but in the coordination of the reactor with the suggested arrangements for producing electric power. While intimate knowledge of reactor design principles and methods of operation would be helpful to the power engineer, he is less concerned with specific details of reactor design than he is with the temperatures at which they can operate, the types and characteristics of coolants used, quantities of flow, pressures, sizes of piping and ductwork needed, the types, sizes and capacities of pumps, fans, heat exchangers and other auxiliary equipment involved. He is vitally interested in the specific details of plant arrangements, and, of course, in the economics of proposed plants. It is further necessary for the power engineer to understand thoroughly the nature and operating characteristics of reactor control systems since the control of the reactor must be integrated with the control of the generating station as a whole. He is vitally concerned with the operating temperatures of the reactor elements, with the heat release, and the heat transfer characteristics of the coolants.

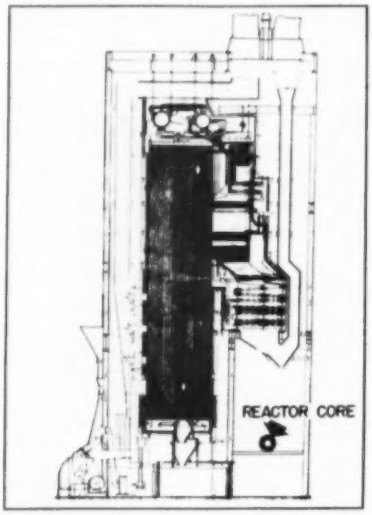


**Fig. 4. Nuclear reactor core compared with a modern reheat boiler of the same power rating**

There has been considerable misunderstanding and misconception, among power engineers, concerning the nature of atomic power plants that might be built. From long familiarity with existing plants and thermodynamic cycles they assume that nuclear power plants will have to operate on the same high temperature, high pressure steam cycles that characterize modern fuel-fired plants.

Even a cursory reading of the edited reports will indicate that this is not so. All plants involve the use of conventional steam turbines supplied with steam from heat exchangers (boilers) which, in turn, are supplied with heat from the coolant flowing through the nuclear reactors. Note, however; in only one instance does the design of these plants involve steam at a pressure higher than 485 psig nor at temperatures higher than 750 F. Indeed, one of the plants (Monsanto-Union Electric) is designed for steam at 165 psig, saturated. Even at this low pressure the power output called for is 220,000 kw in two turbo-generators of 110,000 kw each!

These steam pressures and temperatures are something for the power engineer to contemplate since they are very much lower than those used in our modern high thermal efficiency plants. If nuclear power plants come into use, we may have to go back to pressures and temperatures which were in use 20 and 30 years ago. This is not, necessarily, a foregone conclusion, however, since, as one study indicates (Detroit-Dow) reactor operating temperatures as high as 1500 F might be utilized in the case of certain types of proposed reactors. Assuming, however, that the lower pressure-temperature range prevails at least in the early development of atomic power, it will result in the use of much larger (physically) equipment than is used at present. In the use of the liquid-cooled plant proposed by the Commonwealth Edison-Public Service of Northern Illinois group, each of the three 80,000-kw turbo-generators comprising the plant will need four 35,000 sq ft condensers. This amount of condenser cooling surface ordinarily would be sufficient for a 200,000-kw turbine at conventional steam pressures.

The steam equipment including the piping will therefore be much larger in physical dimensions in the atomic power plant than it is in the conventional high-pressure steam plant. The thermal efficiency also may be lower but where plutonium production is involved, the question of thermal efficiency becomes of secondary importance, and power engineers may have to revise their ideas concerning the relative importance of efficiency in the design and operation of atomic power plants.

# Industrial Study Groups Report on Power Reactor Feasibility

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**For a copy of the complete report write to the Editor, on your company letterhead asking for a copy. Anticipating an immediate need for the report by many engineers and some delay from official sources, a limited supply has been obtained. These will be sent without charge, one to a reader, as long as the supply lasts. The report is available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 25 cents each. The title of the report is "Report to U.S. Atomic Energy Commission on Nuclear Power Reactor Technology"**

THE MOST SIGNIFICANT FACT concerning the studies on Power Reactor Feasibility by the four industrial groups, as indicated in the preceding article, is the divergence in the methods of attacking and solving the problem. The reports show how four groups of engineers, starting from scratch but with a common objective, working independently, arrive at very different solutions. This knowledge should inspire other engineering groups to tackle the problem in still other ways and thus, ultimately, bring about the development of practical and economically competitive nuclear power plants.

We *will* have nuclear power plants, make no mistake about that. Until recently, power engineers generally have not been overly enthusiastic about atomic power. While they did not completely discount the development of nuclear power plants, they felt they were a long way off. As these studies show, however, the generation of electricity from nuclear energy is much closer than most engineers could have foreseen even two years ago. Instead of discounting the possibility of developing atomic power plants on an economic basis in the foreseeable future as they were inclined to several years ago, utility engineers, now, are actively interested, and many other utility companies besides the four groups issuing these reports, are actively engaged in the development of atomic power plants.

Many of the large manufacturing companies also are actively engaged in the construction of facilities for the manufacture of atomic power equipment. The quantity of industrial *know-how* that is accumulating is almost beyond comprehension. New methods, new principles, new techniques, and new concepts are being uncovered every day. A vast new literature is building up, much of it, unfortunately, still classified but the time is coming when most of this will be available to industry. Nothing can stop it. The pressures from all points of our economy will force these techniques to be revealed. A fuel with a potential heat value of 40 billion Btu per lb simply cannot be ignored.

Lest you be concerned about the supply of fissionable material in the World, don't be misled by the dire predictions of those who merely assumed that the uranium deposits are extremely limited. True, they are not abundant in terms of billions of tons, as for coal, but you don't need much uranium to run a power plant. As Dr. Hafstad has pointed out, there is actually more energy in a ton of granite, that is, in the small amount of uranium in granite, than there is in a ton of coal. Of course, it would be difficult and inordinately expensive to extract it, but it is there. Lately, there has come into use a new term for expressing large quantities of heat energy. This term is the Q, equal to $10^{18}$ Btu, a very large number. In terms of this large unit, the known coal resources of the world are estimated to be between 36 and 70 Q. On the same basis, and assuming that breeding is possible, the uranium resources of the world are estimated to run from 1000 to 1700 Q.

In view of these facts it is quite understandable that the electric utilities should be interested in the development of atomic power. It is even more understandable after one has studied the reports of the four industrial study groups.

In the studies, each group developed at least two designs, one permitting immediate construction, and another involving more development problems but having greater future promise. For the sake of comparison these various designs can be described briefly as follows:

Commonwealth Edison—Public Service Co. of Northern Illinois

Two conceptual designs, both using natural uranium as fuel.
A. 350 megawatt (heat) 60 megawatt electric power, helium-cooled, graphite moderated reactor.
B. 1064 megawatt (heat) 211.5 megawatt net electric power heavy-water-moderated and cooled reactor.
Total estimated costs, $40,000,000 and $118,000,000, respectively.

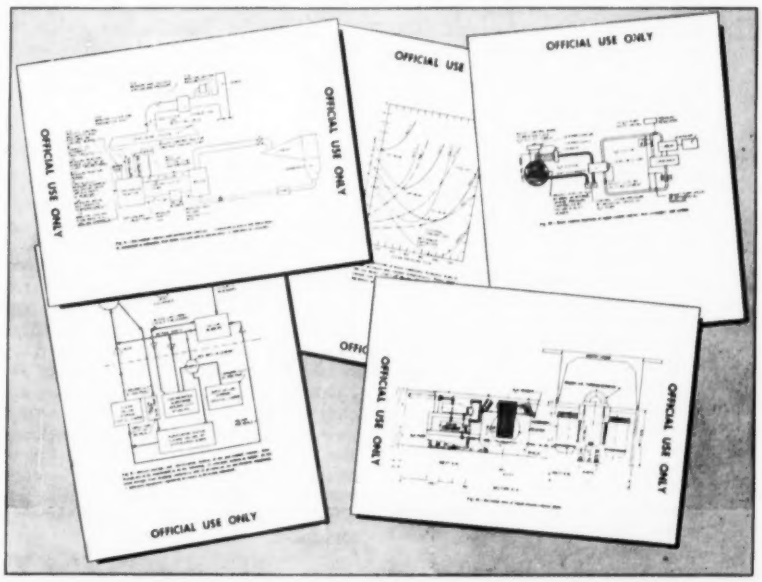


**Fig. 1. Pages from the official report showing the character of the illustrations**

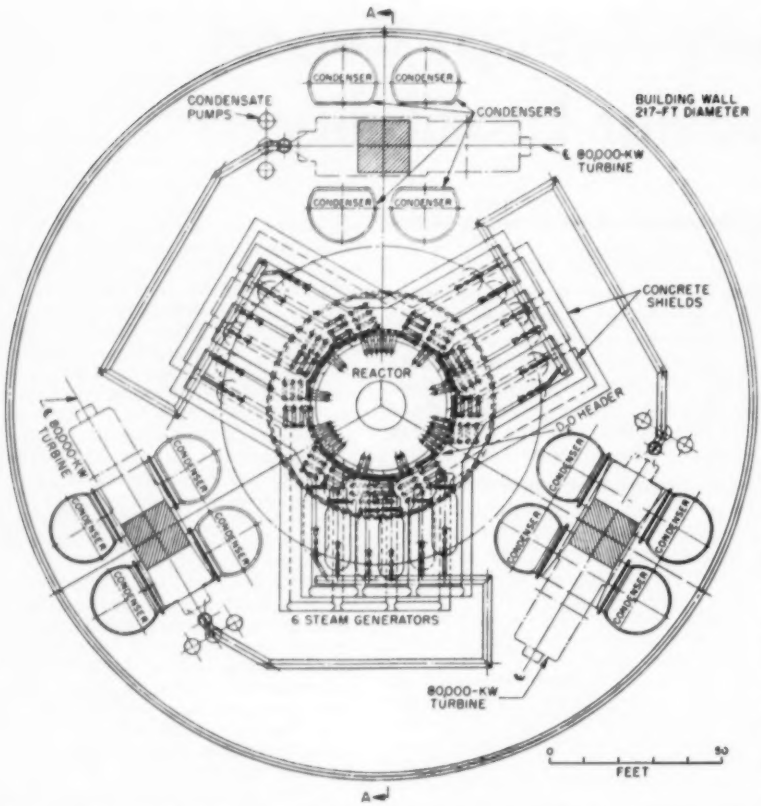


**Fig. 2. Plan view of the liquid-metal-cooled reactor plant proposed by the Commonwealth Edison-Public Service Co. of Northern Illinois group**

Pacific Gas & Electric Co.—
Bechtel Corp.

A. Light water-cooled, thermal reactor using natural uranium fuel rods. Reactor to be cooled by the flow of $H_2O$ through steam generator. Fuel rods to be surrounded by $D_2O$ moderator.

B. A liquid-metal-cooled *fast* reactor using enriched uranium fuel rods. Cooled by a liquid metal stream which in turn gives up its heat to form steam in a steam generator.

Monsanto Chemical Co.—
Union Electric Co. of Missouri.

Two preliminary conceptual designs, both sodium-cooled, natural uranium, graphite moderated reactors.

A. A reactor using internal cooling of the fuel elements.

B. A reactor using both internal and external cooling of the fuel elements.

Detroit Edison Co.—
Dow Chemical Co.

Several conceptual designs of reactors differing markedly from reactors of known technology and designed for operation at considerably higher temperatures than the reactors of the other company groups.

Unfortunately because of the highly classified nature of the reactor technology involved in the Detroit-Dow systems less actual data can be given regarding these studies than those of the other groups, but the chances that these systems will ultimately prove feasible are excellent.

The release of these four reports should be of inestimable value to the engineering profession even though, for security reasons, specific reactor details must be withheld.

### The Commonwealth Edison-Public Service Study

As indicated above, the Commonwealth Edison—Public Service group chose the gas-cooled reactor first because there was more information available on this kind of reactor. It consists of two colinear graphite cylinders with adjoining end faces parallel but separated by a small gap. The fuel channels are parallel to the cylinder axes and are cooled by helium gas which enters the system through the gap between the cylinders. The fuel slugs are of natural uranium metal with a center hole and provided with fins which support the slugs in the channels.

The coolant, helium, was selected since it has no chemical reaction with uranium and zero neutron absorption cross section. Also, it has high specific heat but low density. Since pumping requirements for circulating the gas are directly proportional to the volume, pressurizing the helium will decrease the fan power needed. Hence, operation will be at a helium pressure of about 10 atmospheres.

The reactor requires a spherical vessel 44 ft in diameter. The total heat output will be 350 megawatts. The helium inlet temperature will be 450 F and the outlet temperature 742 F with a helium flow of 3.27 x $10^6$ lb per hr. The boilers will be simple since there will be no ash and no combustion products. The low helium temperature cannot cause overheating of the tubes even if the flow of water is interrupted. It is planned to use 10 boilers, each with a capacity of 90,600 lb per hr. Steam conditions will be 265 psia, 525 F. These 10 boilers will supply steam to a turbogenerator rated at 60,000 kw.

The heavy-water reactor of the CE-PSNI group is based on the considerable work done on this type of reactor at Argonne National Laboratory. This reactor is enclosed in a steel shell built for a pressure of 500 psia. Heavy water ($D_2O$) is used as moderator, coolant, and reflector. The fuel elements comprise a number of separate fuel elements each consisting of an assembly of uranium elements in thin metal casings. These are placed in cylindrical channels. The fuel element maximum surface temperature will be 465 F when the $D_2O$ outlet temperature is 440 F.

Steam will be generated in steam generators, built like conventional evaporators, by heat transfer from the $D_2O$ to the $H_2O$. Steam conditions will be 175 psia, 371 F. The 18 steam generators will be arranged in three banks of six each around the reactor as shown in the plan view of the station in Fig. 2. As will be noted, all the equipment in the circular plant is arranged symmetrically, with the reactor in the center. Each steam generator will produce 180,000 lb of steam per hr. This total, 3,240,000 lb of steam per hr will supply three turbogenerators of 80,000 kw each, a total of 240,000 kw. The total heat developed in the reactor will run 1065 megawatts but this can be raised if a higher velocity of $D_2O$ is used. The cost of this plant is estimated at $118,000,000 or $492 per kw.

### Pacific Gas & Electric Co.-Bechtel Corp. Study

The Pacific Coast group submitted two reactor designs, one having immediate technical feasibility, the other having more development problems but offering greater future promise.

The first design involves a light-water-cooled, heavy-water-moderated reactor. This unit consists of

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an aluminum tank with a multiplicity of aluminum tubes between tube sheets, serving as the container for the moderating $D_2O$. Fuel is placed in pressure tubes which extend through the core tank concentric to the aluminum tubes. Light water, the primary coolant flows through these pressure tubes. The reflector consists of an annulus of $H_2O$ around the tank and a 1-ft layer of $D_2O$ across the top and bottom of the tank. The primary coolant is circulated between the reactor and the steam generator by means of high capacity circulating pumps. The primary coolant pressure will be 1000 psig.

The power developed in the reactor will be 500 megawatts (heat) and the gross electric power, 106.2 megawatts. Steam conditions are 160 psig, 378 F. Steam will be supplied to a tandem-compound, double-flow, 1800 rpm turbogenerator rated at 125,000 kw. The total cost of this plant is estimated at $41,000,000, or $386 per kw.

The second study of the Pacific Coast group involves a liquid-metal-cooled *fast* reactor. This type was selected because of its ability to breed as well as its use of higher temperatures. It produces more fissionable material than it consumes. It would resemble in some respects both the Submarine Intermediate Reactor (SIR) and the Experimental Breeder Reactor (EBR) though it is based more on the latter. Future improved designs could be substituted without altering the basic arrangement of the plant. The reactor core of highly enriched material is surrounded by a breeder blanket composed of either depleted, or natural uranium. More than 90 per cent of the heat production takes place in the core which consists of an assembly of a large number of stainless steel fuel elements.

The reactor (Fig 3) is contained in a cylindrical steel vessel 8 ft in diameter and 8 ft high. Heat is removed from the reactor core and blanket by liquid sodium flowing at high velocity—30 ft per sec. Circulation is maintained by two electromagnetic pumps. The primary coolant (sodium) is pumped to two intermediate heat exchangers, entering at 900 F and returning to the reactor at 600 F. Heat is transferred from the primary coolant to an intermediate coolant, also sodium. This intermediate coolant is circulated by electromagnetic pumps to the steam generators. The secondary coolant enters the steam generator at 850 F.

Steam is produced at 500 psig, 750 F in two steam generators each producing 800,000 lb per hr. These consist of a steam drum, evaporator, and superheat section. The steam is delivered to the turbine throttle at 485 psig, 750 F. Steam is delivered to a single large turbogenerator of 154,600 kw maximum capability, a tandem-compound unit operating at 1800 rpm. Although a relatively low pressure installation, this unit operates on a conventional regenerative cycle with four extractions for feed-water heating.

The total cost of this plant is estimated at $51,000,000. As a dual purpose plant this design will produce plutonium at maximum rate and at the same time power at 6 mills per kwhr. This figure is comparable to the cost of power produced in conventional fuel fired plants. Based on *power production only*, and including a 5-yr. amortization this plant would produce power at 12.5 mills per kwhr. However, after the 5-yr amortization, the power cost will be only 3.6 mills per kwhr. Considering a future improved reactor built for power only, a power cost of 5.5 mills per kwhr is obtained, slightly less than the 6 mills per kwhr figured for a conventional fuel plant.

### Monsanto Chemical Co.-Union Electric Co.

The studies of the Monsanto-Union Electric Co. group were based on the operation of the reactor for the production of military plutonium for an assumed period of 5 years.

Two designs are submitted, both sodium-cooled, graphite moderated reactors. The Hanford reactors were chosen as models. Water, however, would not permit operation at high enough temperatures so pure sodium was chosen as a coolant. Sodium has a low neutron absorption cross section and a high boiling point. The two types of reactors arrived at, have the same general arrangement but differ in the coolant system and in the method of charging. The core is in the form of a graphite prism 24 ft high and 39 ft across the face. It is provided with cooling channel holes spaced on a square lattice. Tubular fuel elements, placed in the holes by suitable loading mechanisms, are cooled by sodium flowing both through the fuel elements and the annular space between the walls of the cooling channel and the fuel elements. The fuel channels can be loaded and unloaded while the reactor is operating at full load. The studies indicate that the most economical operation plutonium-power reactor is one using enriched fuel.

Heat from the liquid sodium is transferred to water to generate steam in special heat exchangers. These are shell and tube type units with double concentric tubes to provide a barrier space between the sodium and water, the barrier space being filled with mercury.

The first Monsanto-Union Electric reactor uses only internal cooling of the fuel elements. It is based on receiving sodium from the reactor at 650 F and returning it at 300 F. The hot sodium produces turbine throttle steam at 150 psia, dry and saturated at a rate of 3 million lb per hr. This is fed to two

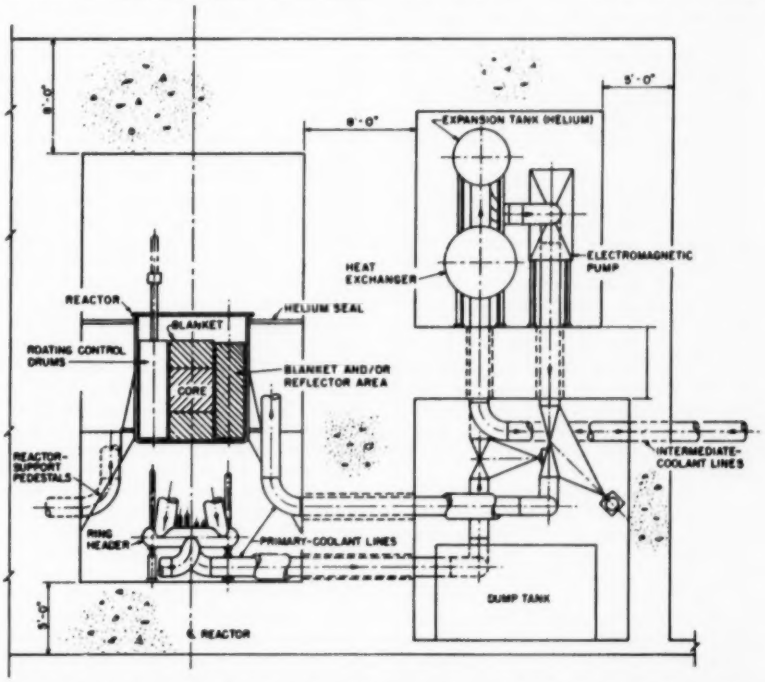


**Fig. 3. An elevation of the liquid-metal-cooled reactor plant of the Pacific Gas & Electric Co.-Bechtel Corp. group**

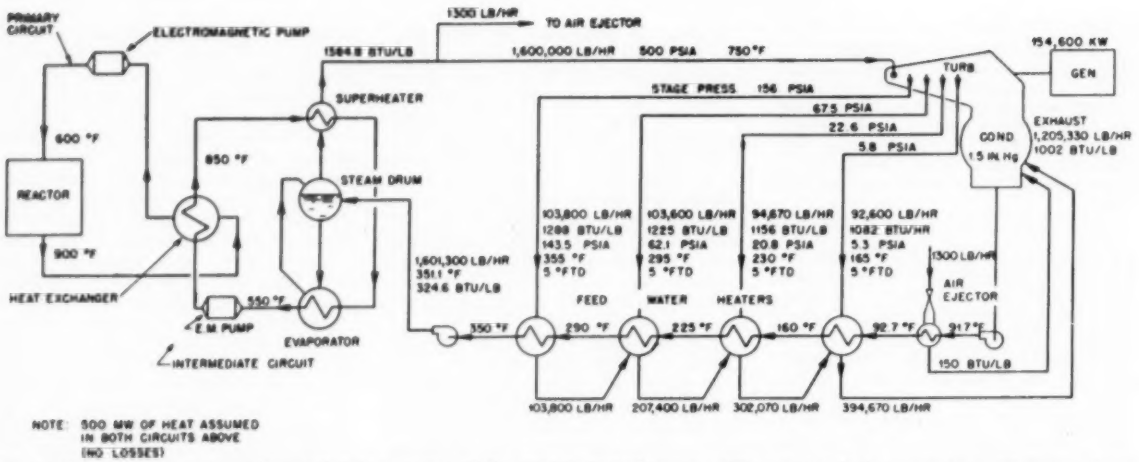


**Fig. 4. Heat balance of the sodium-cooled fast reactor of the PG & E - Bechtel group. FTD means final temperature difference. Gross power, 154,600 kw; net power, 145,300. Net station heat rate, 11,760 Btu per kw-hr.**

110,000 kw turbogenerators. These generating units are far removed from contemporary design practice. They will be very large, physically, requiring four 18-inch steam inlets and will have live steam reheat between stages. The rate of flow to such a large low pressure turbine would tend to make load control by means of steam throttling impractical. Since the production of plutonium is the prime criterion of operation, its production rate should be maintained *regardless of electric demands or turbine availability.* Thus, a separate dump steam condenser would be provided with a capacity equal to the entire heat output of the reactor.

For the second design this group uses a reactor with both internal and external cooling of the fuel elements. They have also developed two power cycles. One of these utilizes the heat output of the sodium coolant over the entire temperature range between the reactor inlet and outlet temperature, 300 to 900 F.

The second cycle rejects the heat of the coolant below 500 F directly into the heat sink. The main advantage of the second cycle is that it substantially reduces the investment and gives a power output of more readily marketable size. The steam conditions for both power cycles are 400 psia, 746 F. In the first cycle steam would be generated at 8.8 million lb per hr, fed to a turbine cycle with a gross thermal efficiency of 28 per cent. It would produce 878,000 kw from 5 turbogenerators.

In the second cycle steam would be generated at 4.8 million lb per hr and produce 579,000 kw in three turbogenerator units. The net output would be 554,000 kw.

These studies are based on a reactor producing plutonium for a period of 5 years. In the first case (internal cooling) power would be produced at 4.13 mills per kwhr, whereas in the second case (internal and external cooling) the power cost would be 3.73 mills per kwhr. This compares with 3.97 for a modern fuel-fired plant.

## Dow Chemical-Detroit Edison Studies

Of the four sets of studies, those made by the Dow Chemical Co-Detroit Edison group are, perhaps, the least specific, yet are the most startling in their implications. Unfortunately, the reactor technology involved is so unique that no details of even the proposed systems can be disclosed.

These studies led to the selection of a liquid-metal-cooled *fast* breeder reactor. This type would provide the high coolant temperature necessary for efficient power production. Originally studies were made of reactors of known technology. It was assumed that a reactor for most immediate construction would have to be a thermal neutron reactor for the conversion of U-238 to plutonium. Power can be recovered from such reactors but it would be at a sacrifice of plutonium production because the power level, and hence the rate of Pu production is determined by the rate of heat removal. For a stationary fuel element operating at a given temperature, the amount of heat which can be removed is, of course, increased as the average coolant temperature is decreased. On the other hand, production of power requires a relatively high-temperature coolant. Thus the production of power and weapons material will be compatible only when the coolant exit temperature is high enough to permit efficient power recovery at, or near, optimum materials-production conditions.

The desirability of a reduction in the chemical-processing and fuel costs indicated the need for a fluid fuel and a much closer integration of the reactor and the separations and decontamination processes. As a consequence, this group concluded that the chances are excellent that molten metal processes can be developed into a superior separations method. If so, it should be more compatible with present reactors and a great deal less expensive than any aqueous processes, particularly if machining and jacketing of fuel slugs can be avoided. If it should be found necessary to use solid fuel, then fuel elements must be of such form or shape that they may be fabricated simply enough to be made by remote control.

A number of mechanical design types are conceivable which might meet all or part of the desired requirements. For example: 1. A jet-mixed centrifugally separated liquid-cooled reactor with liquid fuel and continuous reprocessing. 2. A reactor having liquid fuel contained in a *reactor pot* with the coolant in tubes. 3. Coolant outside fuel tubes and with a liquid or mobile fuel inside tubes, with or without the fast, continuous reprocessing.

The theoretical reactor that would incorporate all the most desirable ultimate objectives is a fast breeder with a true fluid fuel. It would include metallurgical processing and *would not have conventional heat transfer surfaces.* It might be built of refractory materials that would be good for either thermal or high-energy neutrons. The core of the reactor would be *all molten metal.*

The advantage of these fluid-fuel reactors proposed in this study lies in the fact that they are capable of operating at much higher temperatures than conventional types, and in at least one of the five types outlined in this study, the maximum coolant temperature for steam generation is 1020 F.

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# LETTERS TO THE EDITORS

## They're Testing Paint à la Jones

IN THE OCTOBER 1952 issue of POWER ENGINEERING, L. G. Jones outlined a simplified paint testing procedure for testing power plant paints. This procedure, although open to criticism, should supply much valuable information to the individual company in the selection of paint.

We have taken that procedure, changing only a few minor points, and adapted it to our machinery and maintenance needs. We have also included wood and masonry paint tests in our program to cover the selection of building paints. We propose to paint wood panels and common construction bricks, place them in the humid atmosphere of an oven, and evaluate them accordingly.

It is questionable whether this method of testing wood and masonry paint will give the desired information. It seems logical that these paints, and possibly paints for steel, should be exposed to alternate periods of moisture and bright light simulating rain and sunshine.

Have you had any experience with, or know of any method for, testing paints using these materials?

Fort Wayne, Ind. U. W. HAM

*Editor's Note: — Ideas for testing and evaluating paints for steel, masonry, wood and many other materials are given in other articles by L. G. Jones, to be published in future issues.*

## Boom Intake

### He Is Hard to Convince

HAVING READ the article on the new idea for a boom intake screen by George Rodemeyer in the February issue of POWER ENGINEERING may I say that I find the subject quite problematical. From my own personal experience on screen intakes, I would be rather hard to convince from the data on hand.

My experience is only with tidewater steam generating plants where the water level is constantly changing from high to low water twice a day. This presents a different angle from the "5 per cent of the time" that is mentioned in the article. Most of the tidal plants operate on a 10 ft to 15 ft differential between low and high tides, under normal conditions, with added height under full moon.

As you study the section drawing and the enlarged detail of the seals, you cannot determine the weight or bulk of this design, suspended at this angle, I presume, on a series of cables. It must have some buoyancy, and just how much battering the wild waves of a New England northeaster would produce is a question. No doubt it would tip the screen back against the building sea wall.

This design may have some merit as a screen for a penstock opening to a hydro plant. This is purely suggestive, for I am not a hydraulics expert.

I am sorry I cannot agree with the information at hand; however, I would suggest a scale working model; have some college hydraulics laboratory set it up and study its action under simulative conditions bearing on the scale of the unit.

Massachusetts POWER ENGINEER E

### How About Cost & Efficiency?

ON THE NEW TYPE intake screen proposed by Mr. Rodemeyer in the February issue of POWER ENGINEERING, while the suggested design appears to be cheaper than the usual design of intake, there is some question as to its cost and efficiency in many sites.

In locations where navigation limits obstructions into a stream, the projecting boom might make it necessary to push the supporting structure back into the bank with a resulting increase in excavation. The required cofferdamming might cost as much as for the conventional intake, for the site must be unwatered in either case. Where a conventional intake might deflect debris carried by currents, a boom intake would be an obstruction requiring extensive deflectors to prevent damage to the screening equipment.

Under normal conditions, where only a small proportion of the stream flow is being diverted, there might be as effective screening accomplished by this new arrangement. Certainly gravity has been put to good use in that a minimum of screened material is lifted and handled at the top of the screens. However, there is a certain factor of safety that can not be overlooked when racks are installed ahead of screens. Relatively heavy racks have been bent by the impact of transported objects and it is our feeling that screens might be crippled by the force of these objects except for the presence of racks.

It remains to be seen whether operation and maintenance would be simpler with the new type layout. It would appear that ordinary adjustments could be made more easily and cleaning facilitated by the use of the conventional operating floor. Presumably a truck crane would always have to be available to service the screen of the boom intake.

Of course, the proposed experimental unit may show gratifying results and start a new trend in intake design, especially for small units where a single screen and pipe type of intake can reduce the intake structure to a minimum. We should not take for granted that the present pattern cannot be improved upon.

Massachusetts POWER ENGINEER H

## Suggestions

SUGGESTIONS About Suggestions by William Sheffer, May issue, page 78 brings out many interesting points. He is perfectly right in saying that the type of suggestions for new gadgets offered to industrial management is the type to which practically all attention is paid. Quite natural.

One of the best examples of a gadgetry suggestion I have seen recently is the report of a record-shattering suggestion award of $9,000 to Irving Fellows at the Eastman Kodak Co's. Navy Ordnance Division.

The award presented to Fellows for precisely $9,086 is a second payment drawn up after computing savings from an idea for which he had already received $2,300 in January 1953. It brings his total payment to $11,386.

Then Mr. Sheffer also points out that we need more attention on the part of the management to suggestions having to do with major operating policy. Here again I agree with him.

However, there is a point here that I have run into in my own company and Mr. Sheffer doesn't take it into account. It is this: When an employee thinks there is something wrong with a general company policy and tries to do something about it, he often finds that the policy may be justified because of factors management knows all about and the employee doesn't. Management establishes the policy on the basis of a lot of financial, personnel, operating and even social factors that the suggester can't be expected to know about.

Chicago, Ill. AMBITIOUS AL


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Fig. 1. An exterior view of Plant A, showing the new stack constructed for the remodeled power house as described in text

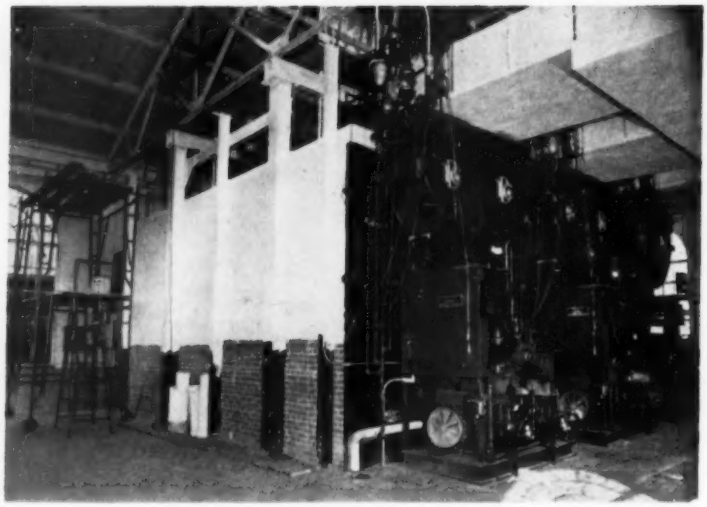


Fig. 2. General view of three new hrt boilers, total capacity 36,000 lb per hr, installed in Plant A power plant of Fig. 1 to replace six old hrt boilers. Reasons given in the text

# Economical Ways to Modernize Small

**By H. D. FISHER**

Consulting Engineer, Westcott & Mapes, Inc.

**Here's what careful engineering has done recently in remodeling some small industrial power plants in New England without spending too much money. The original plants were typical 1900 vintage, with disrated hrt boilers, steam engine generators; plants that were uneconomical, often uninsurable**

ONE DEFINITION of an engineer is: "A man who can do for one dollar what anyone else can do for two." The desirability of living up to this definition has arisen frequently of late in southern New England, where many of the industrial power plants built during the big expansion of the early 1900's are finding their equipment antiquated, uneconomical and at times uninsurable and the engineer is called in to provide a remedy without spending too much money.

Most businesses currently employ depreciation reserves along with other funds for improvements as the need arises, so that when replacement of a major factory unit is required, ready funds are seldom available and expenditures must be held to a minimum.

### What 1900's Plants Were Like

Typical industrial power plants of 1900–1910 consisted of a suitable number of horizontal return tubular boilers (anywhere from three to forty), usually 72 in. or 78 in. in diam with 18-ft tubes, designed for from 125 to 160 psi and hand-fired with coal. Prime movers were practically always reciprocating steam engines: plain slide valve in the smaller sizes, through simple single cylinder Corliss in medium sizes up to compound condensing Corliss in the largest plants.

Motor drives were just being introduced in this period. Power transmission installations in the early years of this period were wonderful examples of the millwrights' art with a maze of shafting, belts and clutches; toward the end of this period, d-c generators, either belted or directly connected, and d-c motors reduced the complications in power transmission.

Factory expansion, increased mechanization and the desirable features of a-c motors gradually worked to displace many of the prime movers as they became outgrown or outmoded. Usual sequence was: purchase of portion of the electric power requirements beyond the capability of the factory power plant; purchase of all the power beyond that which could be generated by process and heating steam (by-product power); and finally, purchase of all power.

For those cases of private plant power generation which survived until the second World War, the steady increase in costs of fuel, labor and repairs during the period since 1939, compared with the cost of power purchased from public utilities, has made only the largest and most economical private plants profitable to operate. In contrast with the steady rise in cost of all items entering into private plant operation, public utilities have, by improved plant design, installation of larger generating units operating on more efficient heat cycles, and particularly by an improvement in load factors impossible to the isolated plant, made possible a gradual reduction in power rates up to 1949, with only very slight advances since that time.

### Rising Costs a Factor

Cost of new equipment, which has increased in the same ratio as plant operating expenses, makes changes in isolated electric generating plant prohibitively expensive, so that when a situation requiring something of the sort arises, a review of the costs will practically always show it is more economical to discontinue prime mover operations and purchase the electrical energy required. Several quantitative measures of this trend are available, as follows:

1 — Bureau of Mines Report of

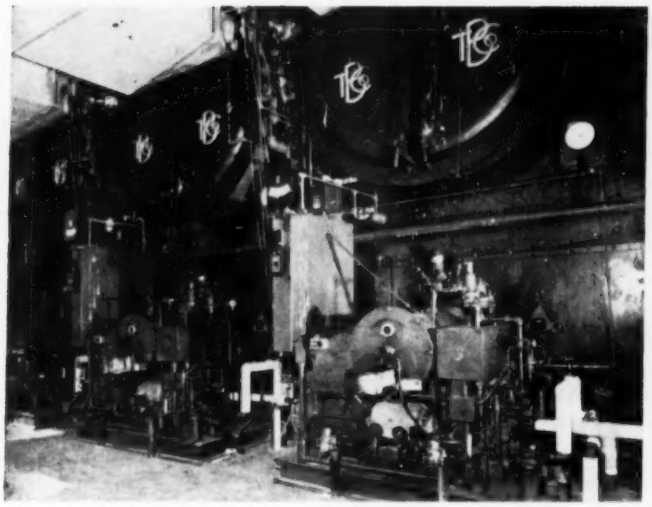


Fig. 3. Close-up view of fronts of new boilers, Fig. 2, showing details of the oil burners and auxiliaries. The old building and fuel oil storage tank were retained

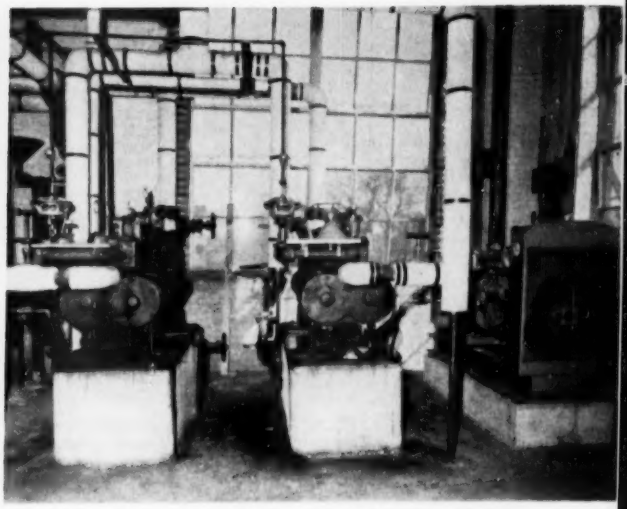


Fig. 4. Remodeled power plant Plant A, new duplex boiler feed pumps were provided; right, emergency gasoline-engine-driven generator set

# Industrial Power Plants

Investigations 4805, Production, Consumption and Use of Fuels and Electric Energy in the U. S. since 1929, 1939 and 1947 by William H. Lyon and D. S. Colby, shows, for 1939, utility electric energy generation of 124,675,000,000 kwh, of which 71.2 per cent was available for manufacturing, while 30,859,000,000 kwh or 28.8 per cent of the total (utility plus industrial energy) was generated by industry. In 1947, however, utilities generated 250,845,000,000 kwh, of which 76.6 per cent was for manufacturing. Industrial generation in 1947 had risen to 47,174,000,000 kwh but this was now only 23.4 per cent of total energy generated in the country.

2 — Again, Federal Power Commission publication FPC S-91 shows that in 1939, industrial generation was 30 per cent of total generation, in 1947 it was 24.8 per cent, in 1951 it was 21.6 per cent. Estimated purchases of electricity were 69.9 per cent of total generation in 1939, were 75.2 per cent in 1947 and were 78.4 per cent in 1951.

3 — Frederick O. Hess, president, Selas Corp., at 1952 Annual ASME Meeting, presented data showing that from 1938 to 1950, bituminous coal purchases by industry had increased 41 per cent; electric power purchases by 205 per cent; oil consumption by 208 per cent; industrial gas consumption by 187 per cent and gross national product by 201 per cent (132 per cent corrected.)

These compilations are all derived from the same basic census data; but several investigators working from different points of view have produced results which correspond closely, as do the ratios of total industrial power purchased from public utilities at the various periods. A plot of the data shows that the portion of the industrial power purchased is increasing quite uniformly at the rate of 0.66 percentage points per year.

### Steam Is a Different Matter

Steam requirements are, however, a different matter. Costs of installing and operating widely-spread steam distribution systems are much greater than the economies resulting from the generation of steam in larger quantities. Therefore, while an industrial plant may easily discontinue its electric generating facilities, the portion of the equipment for supplying heating and process steam must be continued in service.

In remodeling boiler plants in New England at present equipped with horizontal return tubular boilers, several cost analyses have shown that the lowest initial cost of new steam generating facilities is realized by installation of new boiler shells and usually also new settings, placed on the present foundations, and equipping them for firing with fuel oil, usually Bunker C oil. Many of these old multi-boiler plants have already been converted to oil firing, in which case the oil storage facilities and some of the other equipment may be re-used.

This changing to oil fuel in the older plants, while reducing the boiler room labor required, has not always been an unmixed advantage, for practically all the boilers converted were of riveted construction and, at the high steaming rates so easy to attain with oil firing, the sheets have been overheated at the laps of the circumferential riveted joints, resulting in fire cracks and loose rivets.

This situation was aggravated by the fact that, in most of the return tubular boiler installations of that period, the practice was to set the boiler down close to the fire "so as to take full advantage of the heat of the coal". This usually resulted in a setting with the grate 24 in. above the floor and the bottom of the boiler shell 36 in. above the grate. Such a low setting, even when the floor of the furnace was lowered to the practical extent, was likely to allow an oil burner flame at times to touch the boiler shell directly, with serious results.

### Changes in Conditions

To minimize these difficulties in the remodeled installations, welded boiler shells are employed in which there are no laps to thicken up the shell and promote local overheating; and higher furnaces are designed, usually with a minimum of 7 ft 6 in. from the top of the furnace floor to the under side of the shell. This increase in furnace height may be obtained by excavating below the former ashpit level, or by raising boilers and flue, whichever plan is found most feasible for that particular plant.

Usually the original boiler installation designed for power generation

Fig. 5. View of 16 old 72 in. × 18 ft hrt boilers, hand fired with coal; steam pressure 150 psi, in Plant B, which is now remodeled as explained in the text

Fig. 6. These are the 6 new oil-fired hrt boilers, forced-draft, steam-atomizing oil-burner units; total capacity of 60,000 lb per hr that replace the Fig. 5 units

had a substantially larger steaming capacity than is now required for the process and heating service and only a fraction of the number of boilers originally installed will need to be replaced. In such a case, these surplus boilers, if fired with coal, may be laid up as a standby against a possible interruption of the supply of fuel oil although from present indications such an interruption seems less likely than at any time in the experience of the oil industry.

In many cases, design pressures may be reduced, for process work seldom requires more than 100 psig. Under such conditions a design pressure of 125 psi is adequate. This conduces to moderate plate thicknesses for the boiler shells, and to lower costs.

In planning a replacement of boilers as just described, the steam outlet and other steam and water connections are located to match those of the original installation and a minimum of piping changes are required. The same is true of the flue connections, in which minor changes may be required either in the boiler flue-necks or in the run between the last boiler and the stack.

Due to the abandonment of power generating facilities, the steam demand from the boiler plant is usually reduced quite materially. The steam pressure also is quite often reduced. Therefore one of these changes tends to compensate for the other, in that the reduced flow in the steam lines permits the steam at the lower pressure and higher specific volume to be distributed without excessive pressure losses in the piping system.

### Feedwater Heating Steam

As a rule, it is desirable to install steam-driven auxiliaries in plants of this sort. Otherwise, low-pressure steam for feedwater heating would be obtained by passing boiler steam through a reducing valve and a needless expense incurred for purchase of electric power to drive auxiliary equipment such as boiler feed pumps, oil pumps, and the like. In some cases, forced- and induced-fans too are steam turbine driven, usually in the case of central fan systems because maintenance of the number of small steam turbines required to drive individual boiler fans is likely to prove inconvenient. Steam-driven auxiliaries are also very convenient for maintaining steam generation for heating service in case of public utility power failures.

For convenience in operating such steam-driven auxiliaries, operating steam pressure is usually set at 70 to 75 psi even though a lower pressure may be adequate for process and heating steam requirements. This also maintains a reasonable density of steam for transmission in the existing pipe lines. As an example, the accompanying table shows the relative amount of steam that may be transmitted with the same pressure drop or the relative drop in pressure for the same flow when the operating pressure on the system is reduced from a former higher pressure to 70 psi.

### What Can Be Saved?

Ordinarily such a reduction in capacity with the same drop in pressure or increased pressure drop to maintain the same flow will be of no consequence, because boilers for such replacement installations are usually purchased with a design pressure of 125 psi, and a few pounds higher operating pressure to overcome pipe friction would present no difficulty.

It is advisable, however, in planning an installation of this sort, to make a check of the capacity and limitations of the steam piping system when the operating pressure is to be altered radically.

There is a growing tendency to install gasoline or diesel-engine-driven emergency generators to provide against public utility power failures, particularly where the safety devices and combustion control of the oil-burning system are electrically operated.

In many of the older boiler installations, the boilers were supported by lugs resting on the setting walls. In such cases, steel framing must be furnished for the new installation. But where the boilers were originally suspended independent of the brickwork, the framing can usually be re-used; if necessary, raising the boiler support beams by short extensions on top of the columns.

In some instances, cleanout doors, flue doors, water columns, blowoff valves, soot blowers, and the like have been salvaged and reconditioned for re-use; but it has usually been found advisable to furnish at least new safety valves to bring the boilers up to code requirements, also new water glass fittings, gage cocks and steam gages, for their cost does not warrant the expense of reconditioning the old ones.

### Boiler Comparisons

In discussion of the plan here described with the plant owners and their engineers, the relative merits of this plan and of the installation of conventional type water-tube boilers, and of the so-called package type units, have been discussed.

From these discussions the following opinions have been developed:

(1) The proposed plan is particularly adapted to remodeling of plants now equipped with horizontal return tubular boilers. For these plants, the plan offers the following advantages:

(a) Materially lower installation cost due to re-use of most of existing buildings, foundations, piping and flues

(b) Sustained efficiency over a wide range of boiler plant loads due to ability to readily vary the number of units in service and operate them at

Table showing relative steam flow and pressure drop for original and lower steam conditions

| Orig. Operating Press.—Psi (Sat.) | Specific Vol. of Steam—Cu ft per lb | Relative Flow at 70 Psi (Sat.) With Former Press. Drop | Relative Press. Drop at 70 Psi for Original Flow |
|---|---|---|---|
| 200 | 2.13 | 0.64 | 2.2 |
| 150 | 2.75 | 0.73 | 1.7 |
| 125 | 3.22 | 0.79 | 1.6 |
| 100 | 3.88 | 0.84 | 1.3 |
| 70 | 5.17 | 1.00 | 1.0 |

| Manufacturers of Equipment—Plant A | |
|---|---|
| Boilers and flues | Bigelow Co. |
| Boiler settings | W. G. Meade & Son |
| Oil burning equipment Type PK automatic oil burners | Peabody Engineering Corp. |
| Stack | Alphons Custodis Chimney Construction Co. |
| Deaerating feedwater heater | Cochrane Corp. through Turbine Equipment Co. |
| Piping | Foskett & Bishop Piping Co. |
| Boiler feed pumps | Warren Steam Pump Co., Inc. |
| Feedwater filter | Blackburn-Smith |
| Emergency generating set | U. S. Motors Corp. |

| Manufacturers of Equipment—Plant B | |
|---|---|
| Boilers | Bigelow Co. |
| Boiler settings | W. G. Meade & Son |
| Air cooled furnace walls | Laclede Arch Co. |
| Forced draft fans | American Blower Co. |
| Combustion control | A. W. Cash Co. |
| Oil burning system | Peabody Engineering Corp. |
| Fuel oil tanks | Norwalk Tank Co. |
| Deaerating feedwater heater | Cochrane Corp. through Turbine Equipment Co. |
| Piping | M. J. Daly & Sons, Inc. |
| Boiler feed pumps | Ingersoll-Rand Co. |
| Condensate booster pump | Ingersoll-Rand Co. |

| Manufacturers of Equipment—Plant C | |
|---|---|
| Boilers | Bigelow Co. |
| Boiler settings | W. G. Meade & Son |
| Forced draft fans | L. J. Wing Manufacturing Co. |
| Combustion control | Ace Instrument Co. |
| Oil burners | Todd Shipyards, Combustion Div. |
| Pump and heater set | Perfection Grate & Stoker Co. |
| Deaerating feedwater heater | Worthington Corp. |
| Boiler feed pumps | Worthington Corp. |
| Piping | M. J. Daly & Sons, Inc. |
| Condensate return pump | Nash Engineering Co. |
| Emergency generating set | U. S. Motors Corp. |

their individual most efficient ratings This is important where heating comprises a substantial fraction of the steam load with the resulting great variation between Summer and Winter loads

(c) Good efficiency over best operating range of capacity

(d) Ease of external cleaning for lay-up periods

(e) Longer life with equal attendance and care

(f) Substantial overload capacity

(g) Ability to supply large temporary steam demands due to large volume of heated water contained in the shell

(2) Purchase of horizontal return tubular boilers for entirely new installations has certain advantages over equivalent steam generating equipment for small plants supplying heating and process steam only at moderate pressures; these advantages being some of those cited in (1). The advantage in lower cost of installation is less evident when a complete new boiler plant is to be constructed. For such completely new plants water-tube boilers of the conventional type and the more recently developed package type units should be carefully considered and estimates made of the initial and operating costs in a plant design based on such equipment. Their most important advantages and limitations for this sort of service are:

(a) *Conventional water-tube boilers*

Can readily be equipped with superheaters

More suitable for higher steam pressures

More difficult to clean fire side of tubes etc. effectively when laying up

(b) *Package type steam generators, fire tube type*

Low cost of foundations, smoke flues and installation. Excessive auxiliary power consumption. Difficulty of cleaning, particularly on the water side. Capacities are based on rather high heat transfer rates. Cannot be adapted to use solid fuels

(c) *Package-type steam generators, water-tube design*

Some of the recent developments in this field offer numerous advantages at a moderate price because of complete standardization and mass production methods of manufacture. Costs of foundations, smoke flues and installation are moderate because units are shipped fully assembled and have moderate unit bearing weights

Can readily be equipped with superheaters

Normal overload capacity where properly rated

Auxiliary power consumption fairly high

Capacity limited at lower pressures by volume of steam drum

Some designs not well adapted to conversion to solid fuels

Summary of replies to a questionnaire circulated among consulting engineers during the Fall of 1951, regarding the installations of package type boilers in their own practice, showed that they were being quite frequently installed in the smaller sizes, that is up to 20,000 lb per hr steaming capacity. Above this size, the number of installations was relatively very small.

(*Continued on page 133*)

Fig. 7—Right. New deaerating feedwater heater, 12,500 lb storage capacity installed in remodeled Plant B power house also back of boiler control board

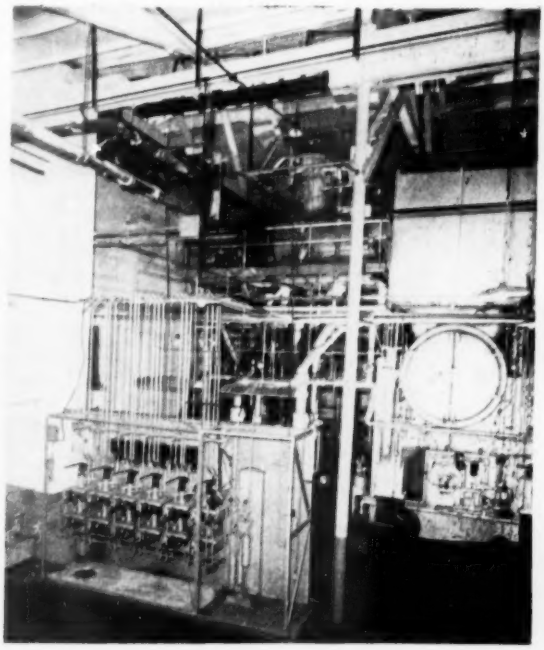
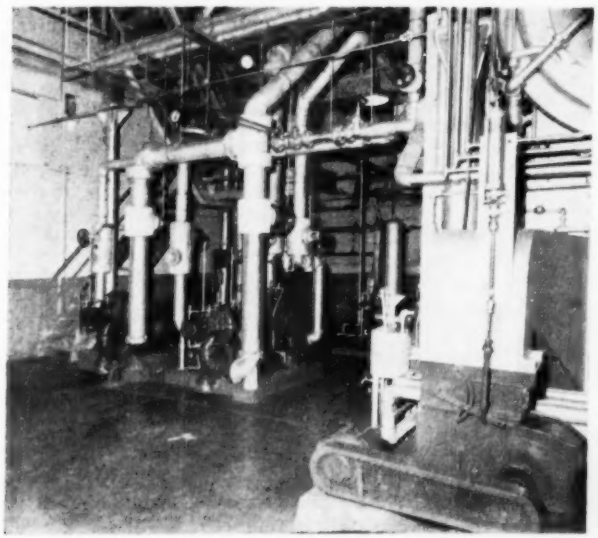


Fig. 8—Below. The new boiler feed pumps in the remodeled Plant B power house



# Petroleum Pitch . . . An Excellent Boiler Fuel

**Pitch is cheaper than coal or oil; it has a higher calorific value than either; combustion is nearly smokeless; and the small amount of residue easily removed. Here is how an industrial power plant has burned it successfully for years**

**By EDWARD J. MILLER**

Chief Engineer, United Chemical and Organic Products Corp.

WHEN pitch burning was mentioned at a recent engineering meeting, general opinion was shown by the following comments: "Pitch is stuff you put on roofs and roads, not in boilers", "You can't keep it hot enough in the pipes", "It can't be pumped", "If it solidified in the pipelines you'd have to take the plant apart to get it out". In spite of these difficulties we have been burning about 300,000 gal of pitch per month successfully for the last few years at a fuel cost of less than 50 cents per 1000 lb of steam, and our plant is still intact.

Most text books do not tell you how to burn pitch in boilers; they don't even tell you it can be burned at all. We had to develop our technique by trial and error, but now it works with less trouble than most coal or oil installations. Information about pitch burning is so scarce that other engineers may be interested to know how pitch can be used as an economical boiler fuel. United Chemical and Organic Products Corp., a division of the meat packing firm of Wilson & Co. Inc., manufacture at their Calumet City plant such products as gelatine, cortisones, sulphuric acid, and other extracts used in the food processing and pharmaceutical industries. The plant operates 24 hours per day, 7 days per week, and the present average steam load of 50,000 lb per hr, at 165 psi, is supplied by four boilers: a 520 hp cross-drum type Springfield, a 500 hp Union Iron Works water tube type; a 608 hp. B & W integral furnace type, and a 520 hp. B & W water tube boiler fired with a chain grate stoker. The first three have Indiana rotary cup oil burners, and they all burn pitch; the coal fired boiler will probably be converted in the near future to a pitch burning boiler.

### What is Petroleum Pitch?

Before explaining how it is burned, let us first describe some of its properties. Petroleum pitch is the residue of crude petroleum after all the volatile oils, including Bunker "C", have been removed. It is used for waterproofing roofs, road surfaces, etc. It sets solid below 220 F, and flows well enough to be pumped above 240 F. Above 300 F temperature it behaves like any thick oil. We have found that it burns best at 350 F. It has a specific gravity of about 1.01, a calorific value between 17,500 and 18,500 Btu per lb, about 3 per cent ash and 3 per cent sulphur. Most of the available data about pitch burning deals with coal tar pitch. This article is concerned with petroleum pitch, and to avoid repeating the word petroleum, when we say pitch, it means petroleum pitch and not coal tar pitch.

When we first began burning pitch in 1941 the ash content was as low as 0.5 per cent. It is higher now because catalytic cracking processes leave more impurities in the residue than old methods of thermo-distillation.

Sometimes a mixture of pitch and Bunker "C" oil, called flux, is delivered from the refinery, depending on the products they have available. This flux sets at a lower temperature than the pitch, but otherwise it behaves the same way.

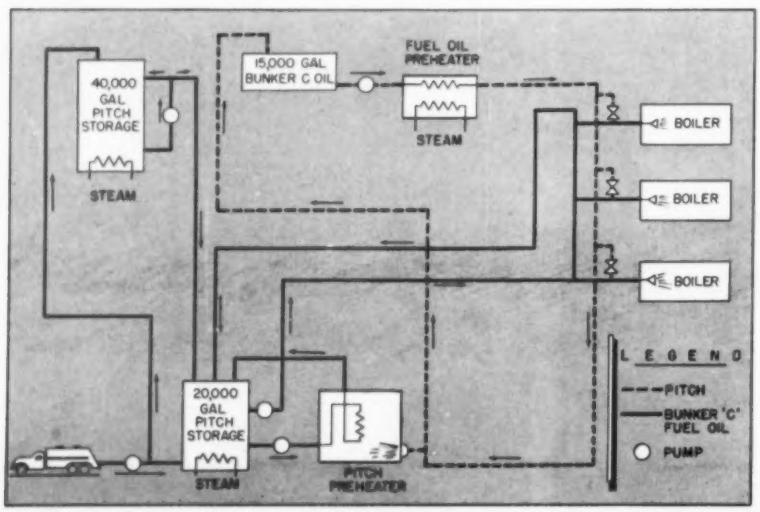



Fig. 1. Diagram showing normal pitch circulating system with an emergency Bunker "C" fuel oil supply

### Combustion of Pitch

Pitch burns with a very hot, practically smokeless flame. It deposits a sticky ash on the back and sides of the combustion chamber and on the tubes, which is easily cleaned off with a high pressure water jet every couple of months. On the floor of the combustion chamber, a hard glazed clinker forms and has to be chipped out with jack hammers every couple of months. The fly ash is very light, and most of it is carried through the boiler and deposited in the bottom of the stack. When the boilers were fired with coal, the bottom of the stacks had to be cleaned out about once a year; now they are cleaned every

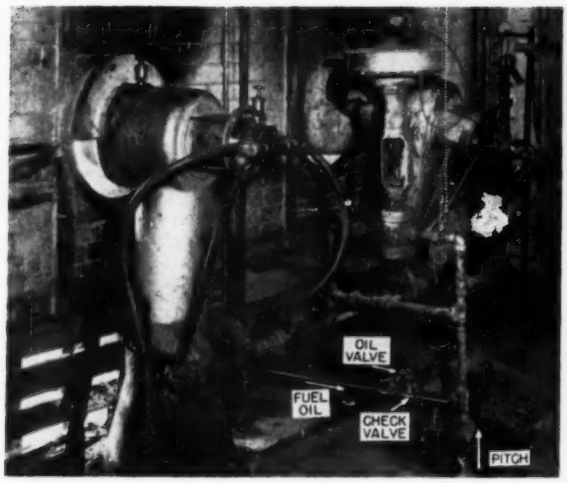



Fig. 2. Shows the normal pitch supply to burners and standby fuel oil piping

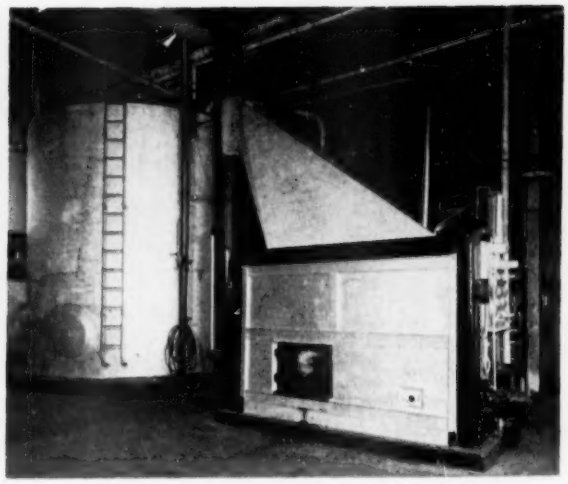


Fig. 3. A 20,000 gal pitch storage tank (left) and oil-fired pitch preheater

six months, which is an advantage, as less ash is deposited in the boiler itself, and cleaning the stacks is easy.

Since 1948 there have been no tube replacements, and there are no signs of corrosion due to pitch burning.

The pitch arrives in uninsulated road tank trucks from the refinery, which is an hour's run from the plant. Each tank holds about 4,500 gal. Hot pitch is put in the trucks at the refinery, and when it arrives at the plant its temperature is about 320 F, so that it can be pumped out of the tank without difficulty. Should anything happen to the normal supply, pitch can be brought in by rail cars. If it is solid when it arrives, it is melted by steam heat until it is liquid enough to pump.

### Unloading the Pitch

At the plant, a 3 inch flexible hose, which has been warmed by a steam jet, is connected to the truck, and the pitch is pumped to storage tanks by an electrically driven gear pump in the plant. The steam jet is also used to clean out the flexible hose when all the pitch has been unloaded from the tank truck.

The piping throughout the system is steam jacketed and lagged. The plant steam pressure of 165 psi is hot enough to keep the pitch fluid in the pipes. Steam jacketed pipes are essential; traced lines are not good enough. Ordinary basket-type strainers are used to trap any solids in the lines.

### Storage

The pitch can be pumped to either of two tanks; an outdoor tank of 41,000 gal or an inside tank of 20,000 gal. Both are lagged and equipped with steam heating coils. The pitch in the larger tank is kept around 300 F. A pump near the tank is used to circulate pitch to keep an even temperature throughout the tank, and to pump pitch from the large tank to the small one. In the small tank the pitch is raised to 350 F, the best burning temperature, by circulating it through a small oil fired pre-heater, shown in Fig. 3. This is a counter-flow convection heater, with a single oil burner using Bunker "C" oil. The pitch is pumped continuously around the circuit, as shown in Fig. 1, and the temperature of the storage tank is maintained by thermostatically controlling the oil burner. If the plant steam had been hot enough to keep the pitch at 350 F, the oil fired pre-heater would not have been needed.

### Burning the Pitch

From the storage tank the pitch is circulated in a loop of $1\frac{1}{2}$ in. pipe to the boilers at a pressure of 50 psi, and each burner feed is tapped off the loop. Pitch not required by the burners returns to the storage tank. The flow to each burner is controlled the same way as ordinary Bunker "C" oil.

Should anything go wrong with the pitch supply to the burners, each boiler can be quickly changed over to Bunker "C" oil without shutting down. This standby arrangement is shown in Fig. 2. Normally the oil valve is closed and pitch valve open, allowing pitch to flow into the burners. To change over to oil, the pitch valve is closed and oil valve opened, allowing oil to flow to the burners. The check valve prevents pitch getting into the oil lines while the valves are being opened and closed or if the oil valve should leak during normal operation.

About 15,000 gal of Bunker "C" oil are kept in an outside steam heated storage tank. It is circulating continuously, passing through a steam heat exchanger, along the front of the boilers, past the oil fired pitch pre-heater, where the small burner picks up its supply, then back to the storage tanks. Thus a supply of warm fuel oil is always available in case of emergency. This is shown in Fig. 1.

### Shutting Down

The oil is also used to keep the burner pipes clear when the boilers are cold. About fifteen minutes before a boiler is shut down, its fuel is changed from pitch to oil; then, when the boiler is cold, it will have oil instead of hard pitch in the burners and pipes which have no steam jackets. The pitch in the pipeline between the burners and storage tank remains in the pipes, where the jacketing keeps it liquid.

Figure 4 shows a useful tool for cleaning the burner cup; it is made from half in. steel rod, and the hook is rubbed over the rotating cups every couple of hours; this prevents the build up of coke or

*(Continued on page 112)*

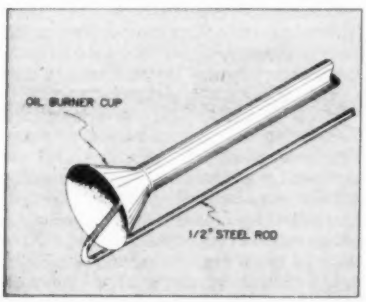



Fig. 4. A ½ in. steel rod used as shown, while burner is operating, stops coke building up on cup

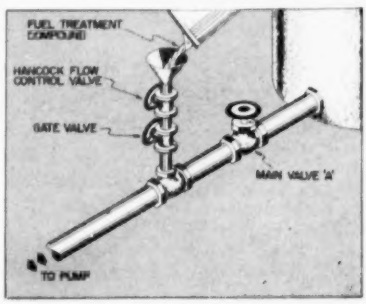



Fig. 5. Shows how fuel treatment liquid is introduced into hot pitch system on the suction side

# Electric Regulation Systems— Key to Higher Production

By **W. R. HARRIS**
Industry Engineering Department,
Westinghouse Electric Corporation,
East Pittsburgh, Pennsylvania

**Many modern industrial processes would be virtually impossible without the use and coordination of the different automatic regulating systems**

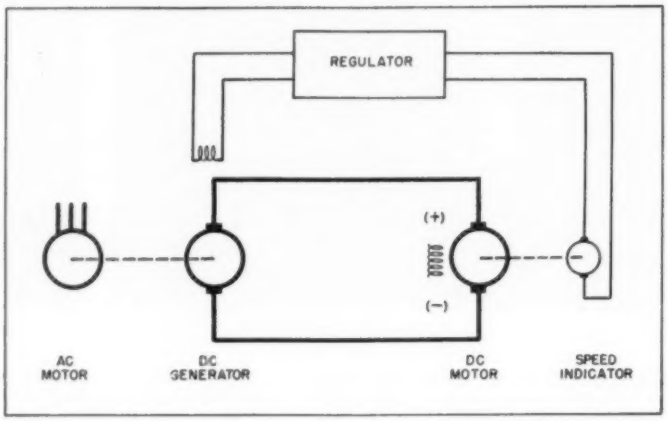



Fig. 2. Shows the typical adjustable voltage drive of the fundamental regulating system

AUTOMATIC REGULATING SYSTEMS are a well established and integral part of electric drives for every major process industry. There are numerous and valid reasons for this. The push of competition has forced operating speeds higher and higher in an effort to get more production from a given unit. The horsepower of drive systems has climbed directly with the speed. These advances in the art of producing goods of all types and varieties transcend the abilities of human operators, no matter how expert. Human hands are just not fast enough to twist the knobs and push the buttons with the dexterity needed to steer today's work horses on their breakneck gallop down the road of increasing industrial production. This has resulted in the ever expanding use of automatic regulating systems, designed to control today's mechanical giants smoothly — yet with authority.

What is a regulating system? A system familiar to most everyone is shown in Fig. 1, which illustrates a regulating system applied to the heating plant of a residence. Figure 1A shows a manually controlled system in which the amount of fuel fed into the furnace is controlled by a manual valve. As the outside temperature and wind velocity changes, the room will become either too hot or too cold necessitating manual control of the input to the furnace. As all of us know, this is difficult. If uniform temperature is to be maintained there must be constant "fiddling" with the fuel input, as well as opening windows and doors and changing clothing to compensate for errors.

### A Regulating System

Figure 1B shows a regulating system which will keep the heated room very closely to the same temperature regardless of outside disturbances. The system consists of a thermostat to detect changes in room temperature, an amplifier which is usually an electrically operated valve, and the furnace and duct-work connecting it to the room to be heated. The thermostat contains a basic error detection and comparison system. The bi-metal element is in the shape of a spring and serves both as a comparison reference and as a means of sensing temperature changes. The spring contracts or expands with temperature changes to operate contacts which control the electrically operated valve.

An industrial regulating system applied to an adjustable voltage direct current drive is shown in Fig. 2. The system is a speed regulator for a direct current motor and it is directly analogous to the above illustration. A tachometer generator driven by the motor serves as the speed indicator and feeds this signal into the regulator. Here the signal is compared with a performance standard. If there is any difference between the performance standard and the speed, the regulator will amplify the difference and change the generator voltage in such a direction as to bring the speed back to normal.

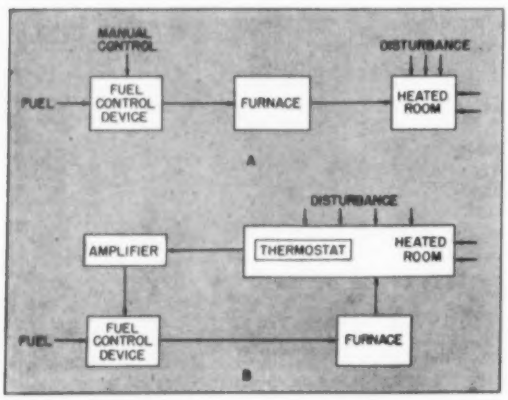



Fig. 1. Fundamentals of manual control versus automatic regulated systems applied to home heating plant

### Types of Regulators

Such systems can be used to regulate speed, current, voltage, torque, or any combination. The regulators may be of the rotating, magnetic amplifier, electronic, or electromechanical types. Each of these has a means of detecting the error, comparing the error to a standard or pattern, amplifying the difference between the two, and applying a correction in the proper direction. All regulating devices and main rotating machines have time delays such as caused by capacitance or inductance of the circuits and flywheel effect of the rotating masses. Such time delays often cause overshooting or instability and so most regulating systems also have damping devices to prevent harmful oscillation.

The foregoing comments have stressed regulating systems rather

than the regulators themselves. It is important to remember that the regulator is only one component of the total system. To obtain the most from the whole system, good regulator design must be coupled with good basic motor and generator characteristics as well as good control. All must be tailored to fit the particular application. The regulating element, no matter how excellent, cannot fully compensate for improper characteristics in other parts of the system. For example, an inadequate furnace will result in cold rooms no matter how excellent the thermostat. Excess saturation in a generator can lower system amplification and impair system performance just as effectively as a poorly applied regulator.

Steel strip used for cans, refrigerators, stoves, automobiles, and toys is the product of a tandem cold reduction mill such as that shown in Figs. 3 and 4. Tremendous pressure is applied to the rolls so that the metal thickness is cold reduced as illustrated on the sketch. As strip thickness decreases the speed of each successive stand must increase accordingly. The metal is threaded to the stands at relatively slow speed and the mill then accelerated to operating speed. Near the end of the coil the mill is again decelerated to slow speed to let the end of the coil travel through the mill without damage, after which the process is repeated for the next coil.

Fig. 3. Installation view of a four-stand tandem cold reduction mill, cold reduces steel strip from 0.1 to 0.01 in. thickness. Total horsepower applied to drive such mills varies from 10,000 to 20,000 hp

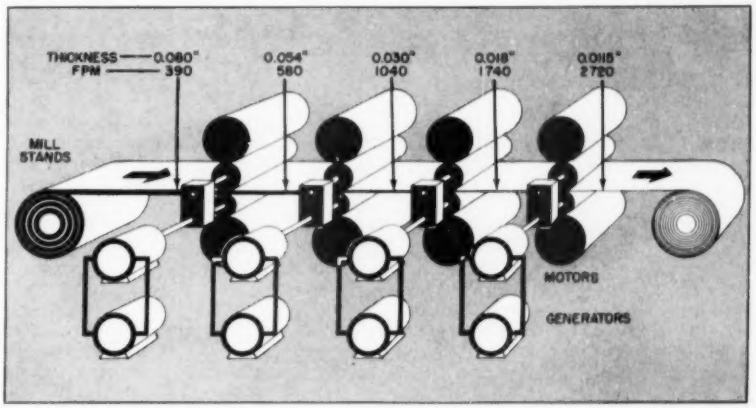



Fig. 4. Schematic arrangement of a tandem mill with the individual generator drive showing the thickness and the speed of the strip between the stands showing the steady rise in the top speed of the mills

## Steel Regulator Systems

Many technical advances in drive equipment have been necessary to obtain operation at these speeds and to control the tremendous amount of horsepower involved. Outstanding among these is the individual generator drive system, which requires a regulating system but has exceptionally quick response and stability. The schematic diagram of such a system is shown in Fig. 5. This shows two stands of a typical mill. With the individual generator drive the voltage of each generator is matched to a reference bus voltage through a precise control system that is in full control from standstill to maximum speed — an infinite range. The mill is accelerated or decelerated by changing the reference bus voltage. The system shown uses the Magamp — a magnetic amplifier-regulator, a relatively new development in regulating systems which is finding increasingly wide application on industrial drives.

The generator voltages are compared to the reference bus which serves as a standard of performance. Any difference between the generator voltage and the reference bus is amplified by the control and power Magamps which exert correction on the generator field. To compensate for the resistance drop in the armature circuit of the motors, an IR-compensation Magamp modifies the voltage relationship between the generator and the reference bus. Such compensation is used on all modern drives to improve acceleration characteristics so that the motor speed more nearly follows generator voltage, to insure that the metal reaches proper gauge quickly during acceleration, and so that gage is maintained better at the right operating speed.

The current limit Magamp is used to prevent the motor current from exceeding the commutating abilities of the machine during emergency stop. It does this by controlling the collapse of the reference exciter volt-

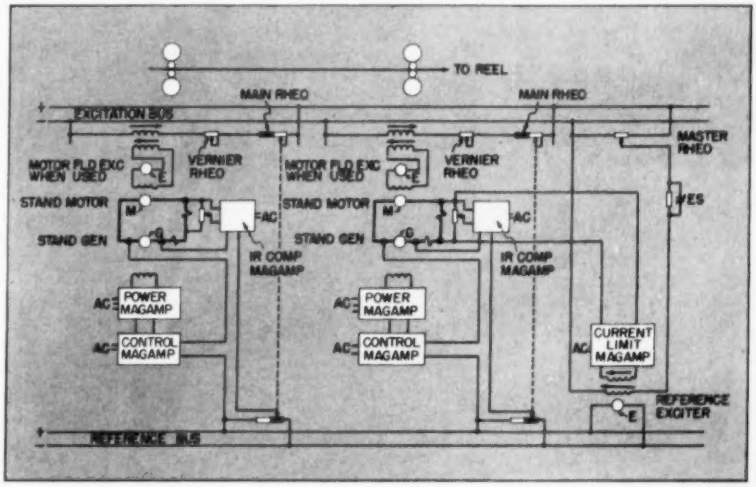



Fig. 5. Schematic diagram of Magamp magnetic amplifier regulating system for individual generator tandem cold reduction mill drive. Systems give exceptionally well damped, quick response performance

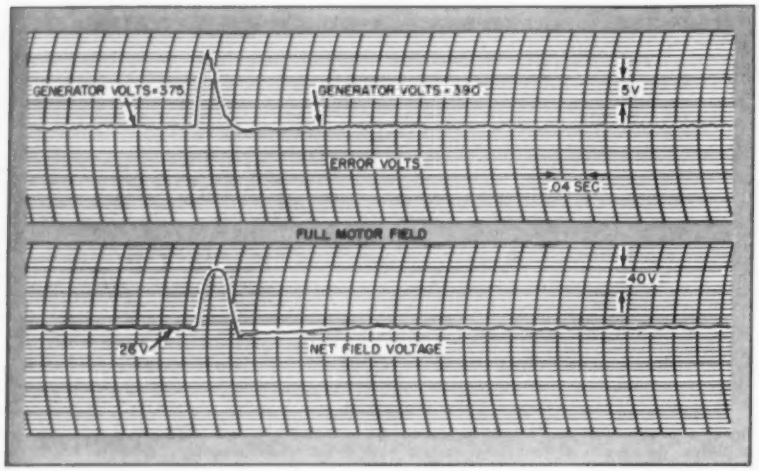



*Fig. 6. Transient response of the Magamp magnetic amplifier of the tandem mill regulating system to an instantaneous insertion of an error voltage. The response is both exceptionally fast and well damped*

age. Such apparatus is necessary because of the extreme difficulty in stopping high speed mills. The stored energy in the mill increases as the square of the speed, whereas the horsepower applied to the mill increases only directly as the speed. If the top speed is increased by a ratio of 15 the stored energy is 225 times as great but the drive horsepower is only 15 times as great. Thus the high speed systems are much more difficult to stop because of the tremendous amount of stored energy involved. Even considering this it is possible to stop a mill running about 4500 fpm in from 3 to 4 seconds with tension maintained between all stands and the reel. Such performance requires a regulating system which meets the following criteria which are grouped into four main divisions:

1. High steady state accuracy to assure close tracking of all the stands from threading to running speed and to prevent the creeping of the motors at standstill.

2. Very fast and well damped transient response to assure proper tension between stands during acceleration and deceleration and emergency stops and to prevent "rocking" when stopping. Actually the two systems of Fig. 7 can be accelerated from zero to full speed with a variation between generator voltages of from 1 to 2 volts out of 600. Thus the transient response of the regulating systems is matched within $\frac{1}{3}$ of one per cent.

3. Adjustments must be simple and independent of one another so that the system can be quickly installed and maintenance simplified.

4. Most important — system must have a high degree of flexibility so that it can be easily set up to roll a wide range of schedule.

The transient performance of such a system is shown in Fig. 6. These curves were taken by making an instantaneous change in reference bus by switching a battery into the circuits. The correction time or response as indicated by the error voltage trace is less than $\frac{1}{10}$ of a second. The exciter voltage trace shows that the power Magamp voltage rises to $4\frac{1}{2}$ times normal in less than $\frac{1}{10}$ of a second to force this fast system response. This performance is amazing when you consider that in less time than it takes to snap your finger power Magamp voltage rises to many times its rated value to force the correction and then returns to normal to prevent overshooting.

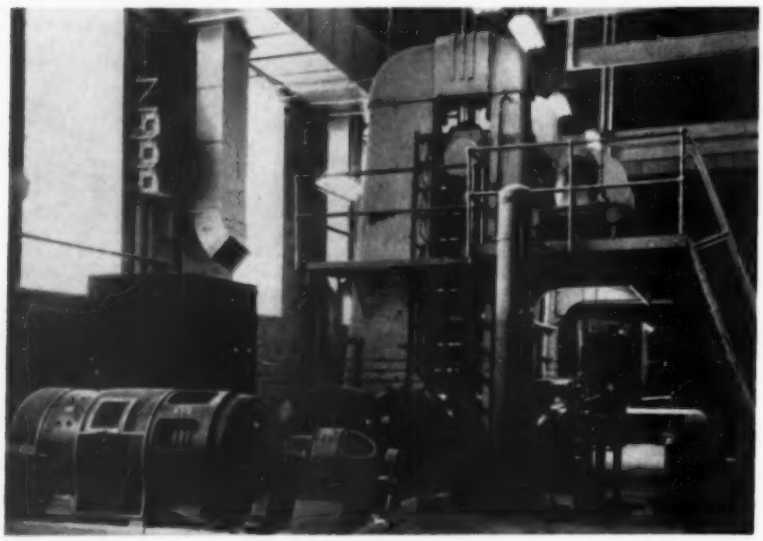


*Fig. 7. View of modern high-speed supercalender used to impart glossy finish to surface of paper. Top operating speed of unit is 1800 fpm; for safety to operators must be threaded at low speed of 50 fpm*

### Paper Industry Supercalender

The supercalender, as shown in Fig. 7, is used to put the hard packed, glossy surface on book and magazine papers. The rolls of the calender are made of steel and a soft material such as paper or cotton and arranged alternately in the stack. The calender is driven through the bottom roll and pressures as high as 2000 lb per sq in. of width are applied. Application of this pressure will cause the load to increase from about 10 per cent to 100 per cent of rated value.

In order to get more production from a given unit the speeds of supercalenders have been gradually increasing. In 1930 it was 1200 fpm, in 1940 — 1500 fpm, and today 2000 fpm is not uncommon. The calender must be threaded by hand, and due to the danger of this operation, the threading speed has remained constant at about 50 fpm. This has resulted in a tremendously wide speed range. This coupled with the major variation in load has made the problem of keeping the threading speed relatively constant a difficult matter. The use of a threading speed regulating system has become mandatory for all high speed supercalenders.

The arrangement of drive elements and regulating equipment for a modern supercalender drive is shown in Fig. 8. Since the regulator is necessary only at threading speed a simplified method of measuring the motor speed is used. It consists of measuring the generator voltage and subtracting from it a component proportional to the resistance drop in the armature circuit. The resultant value is a measure of the motor counter emf which is directly proportional to speed.

### Tension Regulators

The diagram also shows tension regulators applied to the winding and unwinding reels. These modern electric drives have replaced the slip clutch and slip belt drives used on lower speed supercalenders.

Figure 9 shows in chart form the operating speed range of a high speed supercalender. The chart to the left indicates the very low threading speed and the performance of regulated and unregulated drives at this speed. The performance chart to the right is a blown-up version of the speed regulation at $2\frac{1}{2}$ per cent of top speed. It will be noted that the

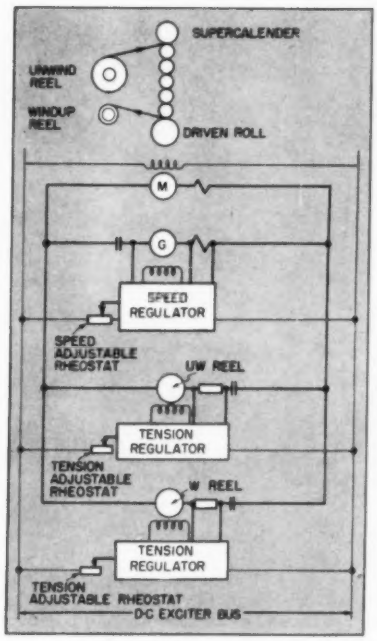



Fig. 8. A schematic diagram showing the arrangement of the drive elements and the speed regulating equipment for high-speed supercalender drive

unregulated drive stalls at less than 40 per cent of rated load whereas the regulated drive has sufficient capacity to meet any load conditions without an appreciable variation in speed. Thus, the addition of a relatively simple regulating system has solved a knotty operating problem.

The continuous electrolytic tinning line illustrates one of the most complex of continuous process equipments found in industry. Figure 10 shows schematically the arrangement of such a line. It operates as follows: The end of a new coil is welded to the end of the old strip, then passes through a cleaning solution, an acid etch tank to prepare the surface of the strip to better take the tin coating, a plating section where the tin is electrolytically deposited on both sides of the strip, a tin reflow section to heat the strip to melting point of tin causing it to flow and change the surface from a dull matte finish to a bright corrosion resistant finish, cooling and drying equipment, oiling equipment for some grades, and a shear to cut out weld before rewinding.

The strip progresses through the cleaning, etching, plating and reflow system while a new coil is being welded or while the weld is cut out of a finished coil. This portion of the line is a truly continuous process. It never stops but due to looping pit limitations must be reduced in speed during discontinuous operation at both ends. Such a line uses several regulating systems as follows:

1. Tension regulators on the uncoilers and reels as well as certain of the pinch rolls or bridles.

2. Loop regulators to hold the storage loops at the proper depth so that when either end is stopped the main process can continue.

3. A regulating system to hold the plating current proportional to the strip speed.

4. A reflow regulating system to control the radio frequency induction heater so that the "flow line" is kept at a certain point as speed or strip conditions vary.

5. A master control system to tie the above operations together and to coordinate the efforts of each.

## Speed Ranges

Such lines are capable of producing tinplate at speeds from 1500 to 2000 fpm. The drive system consists of as many as 134 direct current drive motors ranging in size from 2 to 200 hp. These drive motors must function as a unit during starting, at operating speed, and during slowdown, and must operate successfully over a speed range of approximately 20/1.

The radio frequency induction heating reflow uses 1800 to 2400 kw of 175 kc power. It magnetically induces heat into the strip without touching it. A photoelectric regulator recognizes the point at which the tin flows and keeps it within definite limits regardless of variation in line speed or strip.

This most complex of industrial processes would have been impossible except through the use and coordination of a number of regulating systems. Many more such examples could be used to show that automatic regulating systems are well established in every major process industry. As the push of competition demands more production with fewer manhours, and as processes become more complex, the use of such systems will continue to increase.

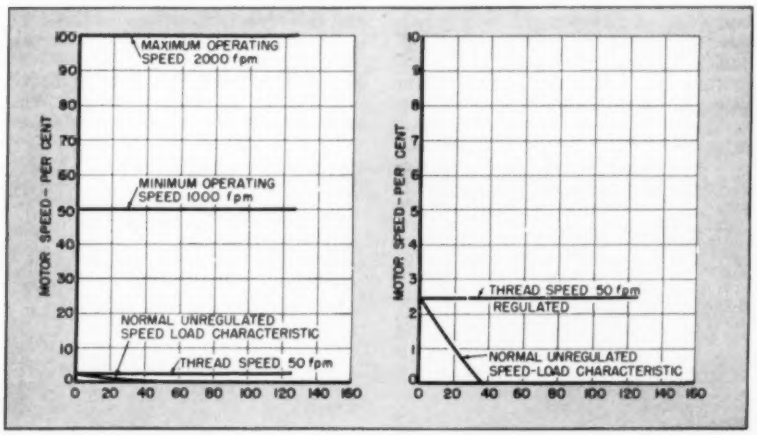

MOTOR SPEED - PER CENT
MAXIMUM OPERATING SPEED 2000 fpm
MINIMUM OPERATING SPEED 1000 fpm
NORMAL UNREGULATED SPEED LOAD CHARACTERISTIC
THREAD SPEED 50 fpm
0 20 40 60 80 100 120 140 160
MOTOR SPEED - PER CENT
THREAD SPEED 50 fpm REGULATED
NORMAL UNREGULATED SPEED-LOAD CHARACTERISTIC
0 20 40 60 80 100 120 140 160

Fig. 9. Operating speed range of modern supercalender. At thread speed equipment will stall at less than 40 per cent of rated load if unregulated, when regulated has capacity to meet any load condition within the operating power range. The equipment arrangement is as shown diagrammatically by Fig. 8

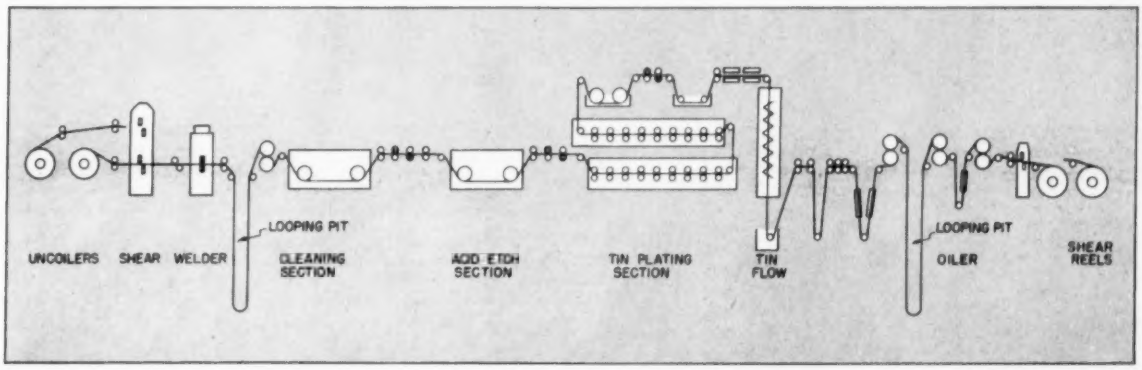



Fig. 10. Schematic diagram of arrangement of continuous electrolytic tinning line illustrating one of most complex of the continuous process equipment arrangements. Details of the operation are explained in the text. Speeds range up to 2000 fpm and may involve as many as 134 motors in sizes to 200 hp

**Generating stations of Commonwealth Edison Co. are provided with spray equipment to control coal dust problem. Installations at Fisk Station and Loomis Yard were recently revamped and system installed at new Ridgeland Station whereby water in combination with chemical wetting agent is automatically mixed and applied to coal at certain points. These systems are used in connection with coal coming by barge as well as by rail**

# Keep Coal Dust Down

ASIDE FROM its nuisance value, coal dust in confined areas constitutes a definite explosion hazard. Any method, therefore, which will eliminate or reduce dust is attractive not only from the standpoint of comfort and health of coal handling personnel but also from standpoint of safety to life and property.

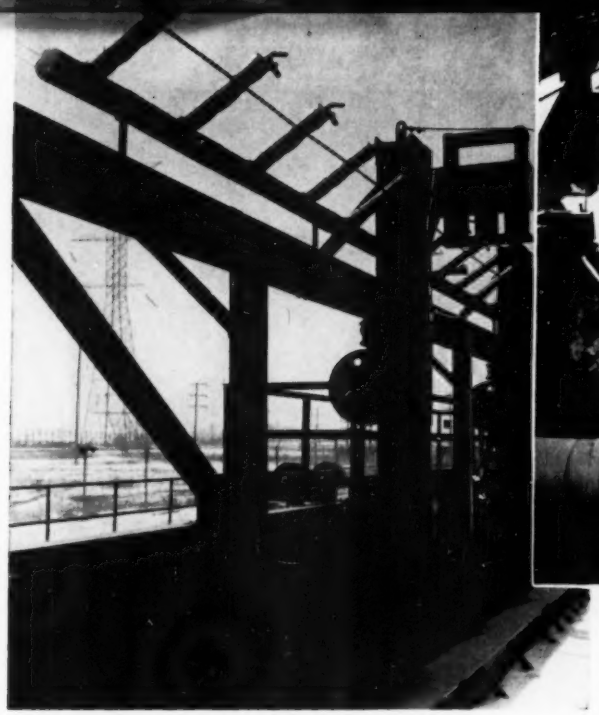
Coal dust is liberated in ordinary coal handling operations at many points in the systems — wherever the coal undergoes sudden changes in position, as at car dumpers, transfer points in conveying systems, and the like. Some coals are more free from dust than others but even washed coal, when it is subject to sudden falls, shatters; and this results in the production of dust. Hence if some means can be provided at such strategic points to eliminate the dust or at least reduce its formation, most of the coal dust problems in power plants would be solved.

It is for this reason that the description of the most recently installed portion of the coal dust control system at the Commonwealth Edison Co. of Chicago, presented in these pages, should be of interest to power engineers generally, because this method has proved very effective. Fundamentally the method is quite simple, involving nothing more complicated than sprays at certain strategic points; but there are features about it which make it much more effective than it would be with the mere use of water.

In this system, a certain chemical compound is mixed with the water in very small amount but sufficiently effective to greatly reduce the surface tension of the water and thus enable the liquid to wet the coal. As anyone who cares to try it will discover, ordinary water sprinkled on fine coal dust has little effect on the dust — it merely rolls off in the same way that mercury rolls off a smooth surface. When a suitable wetting agent is added to the water, however, the action is entirely different; the water

Fig. 1.—Left. This photograph shows dust-control system in action on car dumper at Ridgeland Station of Commonwealth Edison Co. Upper group of spray nozzles has already sprayed coal in car. Now, as coal is about to fall into hopper, a lower row of nozzles comes into action to spray coal as it falls out of car

Fig. 2.—Above. This view shows lower nozzles in full action. Note how effectively sprays blanket entire area through which the coal falls. In this picture, coal is still in the car but is almost ready to take its plunge into coal hopper below the dumper. The sprays are turned on as the car dumper revolves



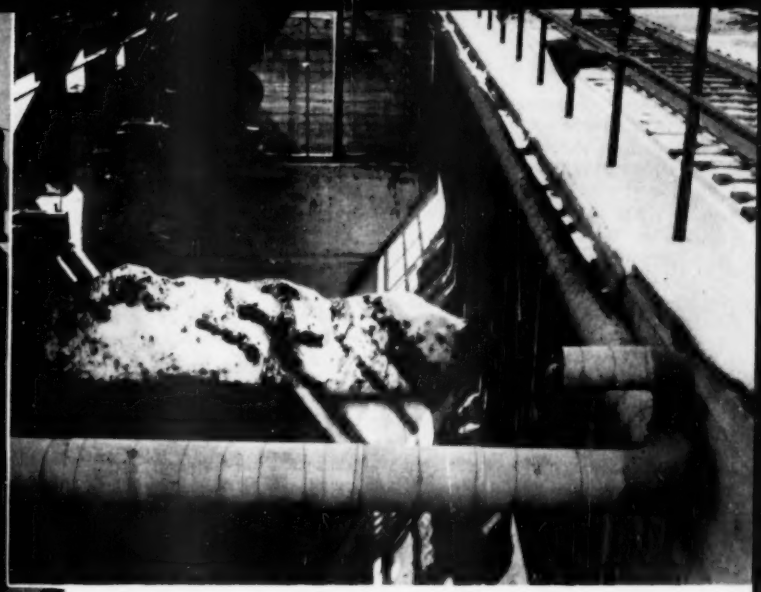


Fig. 3.—Above. This is a view of lower spray nozzle installation on car dumper at Ridgeland Station. Coal may be treated as it falls from feeders below dumper

Fig. 4.—Left. Here is shown upper group of spray nozzles on car dumper at Ridgeland. Nozzles direct sprays on coal while car is still in a normal upright position. As car tips and moves out of range, nozzles shut off automatically

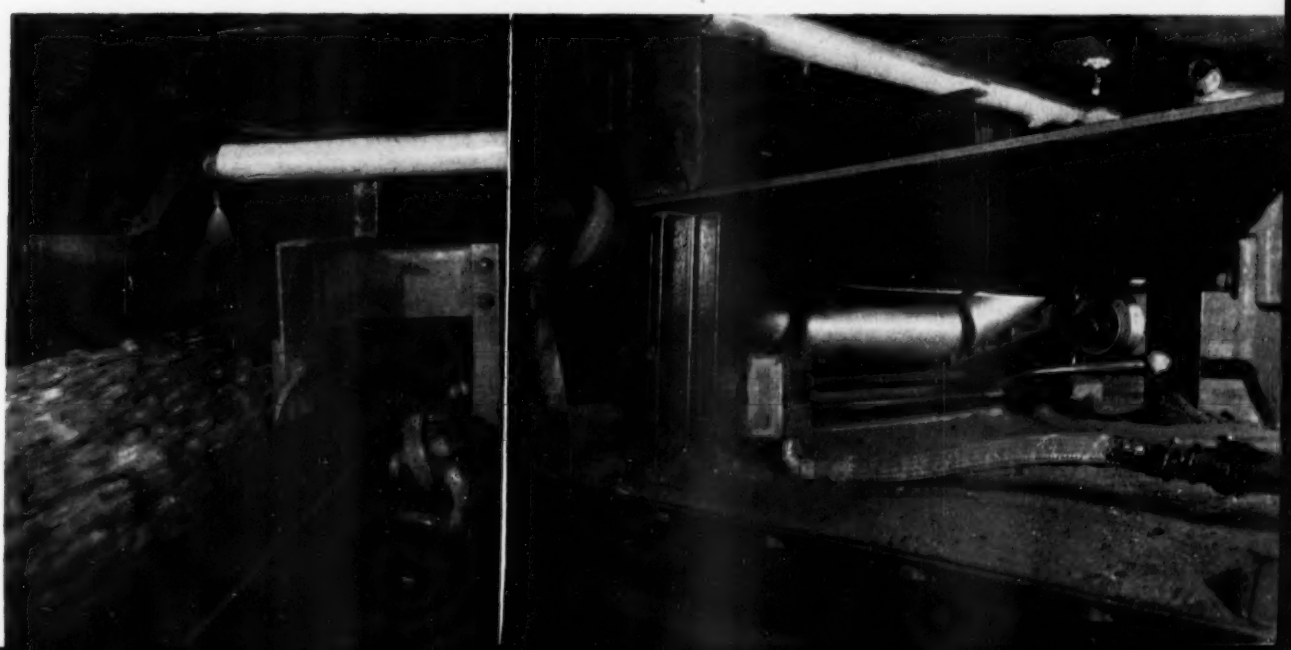
easily penetrates the coal, thoroughly wetting it. The compound used in the Commonwealth Edison installations, for which the Johnson-March Corp. furnished the equipment, is mixed with the water in small but definite proportion and then sprayed on the coal while it is travelling on conveyors or as it transfers from one conveyor to another, or during its transfer from the railroad cars to the conveyors at the car dumpers.

The photographs on these pages show the details of the installation — where and how the sprays are installed and how they are controlled. The systems are automatic in their operation, the sprays being turned on or off by the action of the conveying belts or car dumpers when the systems are in operation.

In the case of the car dumpers, as shown by the photographs of the Ridgeland installation, two sets of spray nozzles are installed, one above the railroad car when it is in normal position on the dumper, and another, lower group that produces a spray blanket through which the coal falls as it is dumped into the hopper. As the dumper starts to turn, first the upper nozzles are turned on by an automatic valve actuated by the movement of the car dumper. This sprays the coal while it is still in the car and continues to spray the coal while it is falling out of the car. Then as the car is turned sideways, the upper nozzles are shut off and the lower ones turned on. These continue to spray the coal until the car is completely empty and then, as the

Fig. 5. View of one of the numerous coal conveyor belts at Fisk Station of Commonwealth Edison Co. showing the spray nozzle continuously spraying the coal as it passes

Fig. 6. The spray shown in Fig. 5 is automatically turned on and off by this idler-controlled switch. When the belt is loaded, it sags between the conveyor idlers and causes the idler to actuate a switch, which causes a solenoid valve to be operated in the spray line



dumper reverses its motion, the lower sprays are shut off. In this way the dust that is normally associated with dumping a carload of coal is effectively suppressed.

This spraying of the coal in the dumping operation in itself is quite effective in reducing the production of dust during subsequent conveying operations. However, a light secondary treatment is necessary after the coal size is reduced in breakers and crushers, or possibly at a single transfer point beyond the initial application. Hence sprays are also provided at such transfer points. A spray installation of this kind is shown in Fig. 5. Here, the coal is sprayed just as it falls on the belt shown from a conveyor above. This spray is turned on and off by the weight of the coal on the belt. When the belt is loaded, it sags, and depresses an idler below the belt (shown in Fig. 6) and this actuates a solenoid-controlled valve in the spray line.

Figure 7 shows how the spray nozzles are installed at the end of a conveyor run, where the coal drops off the end of the belt. Here, the nozzles are installed outside the conveyor housing immediately in front of two round openings through which the spray is directed against the coal falling from the conveyor belt. This method of installation gives convenient access to the nozzles.

To prevent trouble in winter, spray lines subject to freezing conditions are covered with insulation in which heating cables are embedded. In the view shown in Fig. 7, a portion of the insulation has been cut away to show how these heating cables are installed.

The type of mixing and pumping equipment to mix the Johnson-March compound with the water varies with the size of the installation. Where only a few sprays are needed, a comparatively simple arrangement such as that shown in Fig. 9 is adequate. This is the installation at the Loomis Street transfer yard of the Commonwealth Edison Co. Here, the compound is syphoned from a drum in which it is delivered by a small proportioning pump, and is mixed with the water in a mixing header shown above. City water is drawn from the float-controlled storage tank at the right.

A more elaborate installation is shown in Fig. 8. This is the installation at Fisk Station. Here the water and compound are mixed in the rectangular tank at the right. The mixture is then pumped into the spray header system by the pumps shown in the foreground.

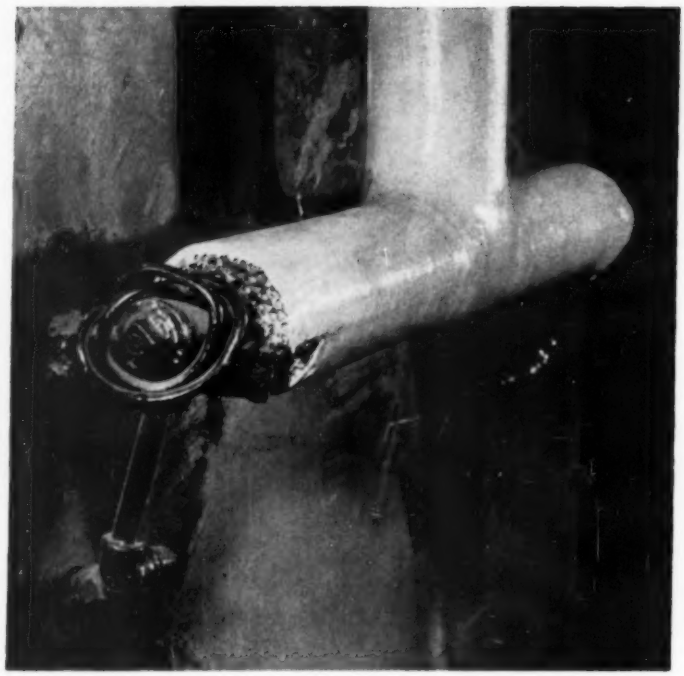


Fig. 7. Photograph shows how nozzles are installed outside conveyor belt housing so that access can be had to nozzles without removing casing. To show how heating cable is installed, a portion of insulation has been cut away. Normally end of header is completely covered

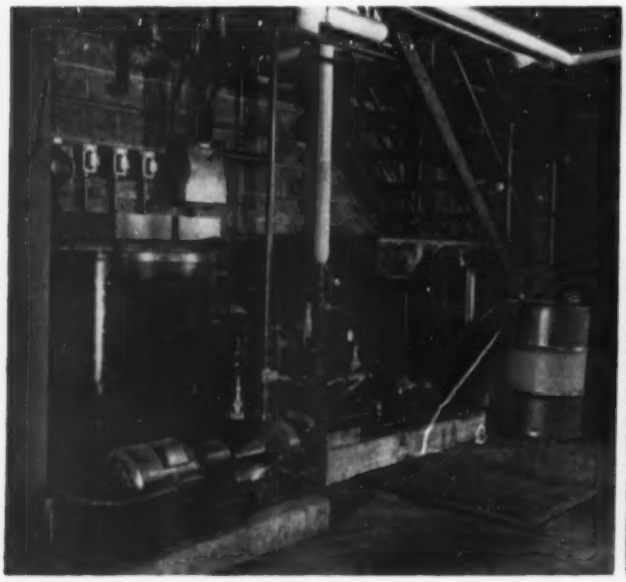


Fig. 8. This shows mixing tank, pumps, and piping at Fisk Station to mix wetting agent with the water. Drum containing concentrated compound is shown at the right. The mixture is pumped into the spray header system by the pumps shown in foreground

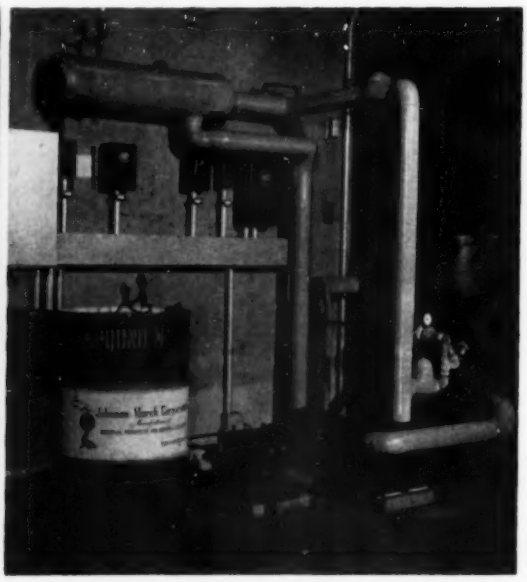


Fig. 9. View of mixing equipment at Loomis Street transfer yard of Commonwealth Edison. Installation shows small proportioning pump feeds Johnson-March compound into water line in proportion to water flow

# Control Your Control Language!

**In 1946 the ASME published a standard terminology for industrial process control. Since then this field has grown rapidly and in 1952 new terms were added and old ones revised. Many users of control equipment may not know these, but they should, for the terms are coming into wider use daily**

IT HAS BEEN SAID that if people would define their terms before arguing, few arguments would develop into quarrels. With industrial control it is not a matter of quarrels but confusion. Designers use one set of terms; manufacturers another; customers another; they mean the same thing and say something different, or they say the same thing and mean something different. Either way the result is a muddle, and the wider the use of automatic controls by industry, the more imperative becomes the need for a common control language.

The Terminology Committee of the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers published a list of standard terms and definitions in 1946. In the next few years the industrial use of automatic controls grew so rapidly that the 1946 list soon became inadequate, and in June 1952 the Committee published an up-to-date list of terms and definitions in Paper No. 52-SA-29, entitled "Automatic Control Terminology," which, in addition to new terms for servo mechanisms and control processes, also revised many old terms which usage had shown to be inadequate. Copies of this paper can be obtained from the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

The paper gives the result of several years' work by a very active committee. They have presented their information clearly, with diagrams and explanations, and they ask for criticism so the new terms and definitions may be revised where experience shows they need improving. They have coordinated their work with the AIEE and the Nuclear Energy Glossary Committee of the ASME in order to use as many common terms as possible.

The paper starts with an alphabetical list of terms, followed by a section on automatic controllers, with diagrams and explanations of such items as an automatic controller and its feedback loop, a self-operated controller, a relay operated controller, setpoint, control point, and the like. Then a section on basic characteristics, defining capacity, capacitance, resistance, dead time, and so on. A section on processes explains self-regulation, the controlled variable, and manipulated variable, and another on characteristics of automatic control explains actuating signal, deviation, offset, cycling, reference input, primary feedback and many other standard terms.

The section on automatic controller action, describes proportional-position action, average position action, floating, derivative, multiple, and sampling action. One on adjustments of automatic controller action defines differential gap, proportional hand, floating rate, reset rate, and another on basic terms explains accuracy in measurement, precision in measurement, error, sensitivity, dead band. There is also a section on block diagrams and automatic control combinations. Block diagrams are first explained, and symbols listed for their use. Then follow combinations with their corresponding block diagrams, such as single, parallel, and series cascade action, summation and calculating action, coupled control element combination, etc.

The paper concludes with an index of non-standard terms in common use, with their corresponding standard terms. The diagrams on this page which have been reproduced from the paper show how well the information is presented.

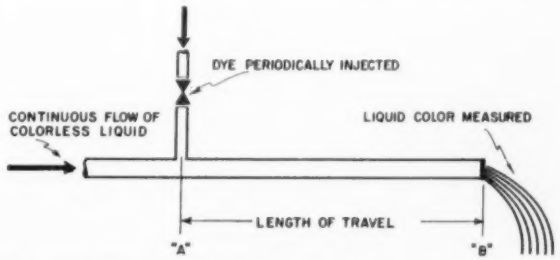
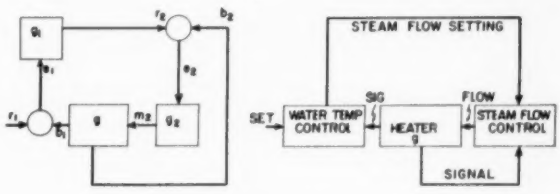



ILLUSTRATION OF DEAD TIME IN FLUID FLOW PROCESS. —

**Let a small amount of dye be injected periodically at point "A" into the continuously flowing, colorless liquid in the long pipe shown above. The dead time is the time taken for the dye to travel from "A" to "B".**

DEAD TIME is any definite delay between two related actions. It is measured in units of time

Fig. 1. This is how the term DEAD TIME is defined, explained, and illustrated in ASME Paper No. 52-SA-29




SINGLE CASCADE ACTION

A COUPLED REFERENCE INPUT OF CASCADE COMBINATION is one in which control output or feedback signals from one automatic controller are used to regulate or readjust the setpoint or modify the reference input signal of one or more other automatic controllers

Fig. 2. COUPLED REFERENCE INPUT OR CASCADE COMBINATION is shown by means of block diagrams

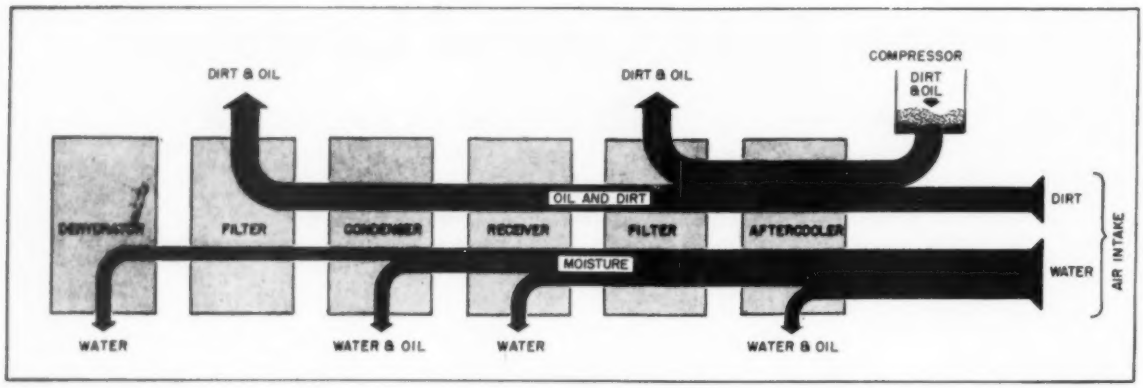



Fig. 1. Diagram showing how dirt, oil and moisture enter a control air system, and how they are extracted progressively between the intake and instruments

# Keep Air Clean for Your Controls

**The best controllers in the world may fail if their operating air is wet or dirty. This article describes how small power plants, which cannot afford the elaborate equipment used by large stations, can obtain clean dry air for their instruments**

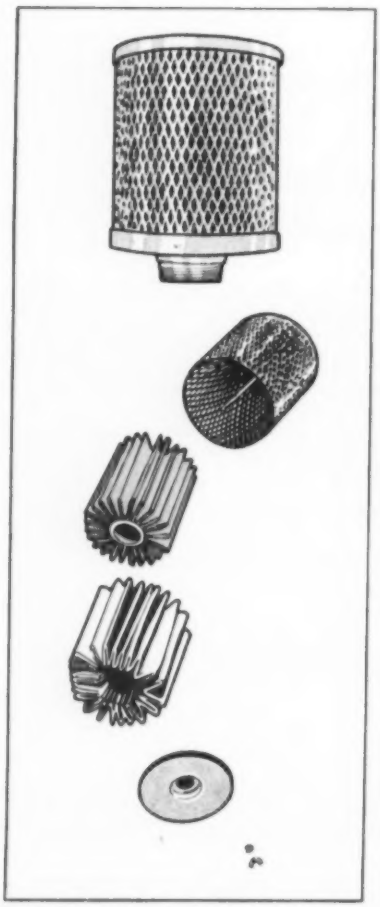


Fig. 2. Parts of a typical compressor intake filter

BEFORE SPENDING MONEY on cleaning equipment, we should be quite clear why it is necessary. Here are some of the troubles caused by three enemies of instrumentation — water, oil and dirt — which are found in every compressed air system.

Dirt is the worst offender, for it clogs instruments and piping. Water is a close second, for it carries dirt; rusts and corrodes pipes and fittings; collects in low spots, causing water hammer which loosens dirt and scale; partly fills the pipes and reduces their capacity, and when frozen, stops flow and may burst pipes. Oil clogs instruments and ruins valve diaphragms.

These are a few reasons why air must be clean and dry if a control system is to work satisfactorily. But how clean is clean, and how dry is dry? The terms are relative; the air which is clean for one instrument will clog another, and air which is dry enough to work in a system at 40 F will freeze and clog pipe lines at −10 F.

The equipment needed will naturally depend on the application, and this article describes first the precautions which have to be taken to get air which is clean and dry enough for most control systems operating above freezing point; the extra treatment it would need to operate below freezing point or with instruments having very small restrictions; the further treatment it would need if the instruments had to operate at temperatures as low as −30 or −40 F, when nearly every trace of moisture has to be removed.

Fig. 1 shows the path of control air from intake to instruments for a plant using a compressor to provide air for the system. We will follow the path of this air and at each stage describe how to prevent impurities getting into the system and how to get them out if they are there.

### Compressor Intake

Ordinary atmospheric moisture is drawn in with the air and cannot be entirely avoided. There are, however, several ways it can be limited. Cold air contains less moisture than warm, and for a given weight needs less energy to compress it; so the intake should be in as cool a place as possible. It should be outside, in the shade, near ground level rather than over a roof where it may be a few degrees hotter; and it should not be near steam, water or other waste discharges.

Atmospheric dirt is also drawn into the compressor intake, and most of it can be caught by a good filter. Locate the intake filter where there is as little dust as possible. Remember that the pulsations of a compressor may loosen abrasive particles from the walls through which the pipe passes, so put the filter several feet away from the walls. Once installed, it is very important to inspect and clean it regularly. Apart from dirt carried into the control system, a compressor using dirty air deteriorates rapidly. Recent tests show that a compressor run without an intake filter has nine times as much cylinder wear as one using filtered air. The filtering element should be replaced as soon as it gets

too dirty to do its job properly. Some dirt is bound to get through, for the air flowing into the compressor is too great for fine filtering, but we must keep out as much as possible.

Wherever possible, piping should be galvanized or made of non-ferrous metal to reduce rusting and corrosion. Beyond the air receiver, all piping should be copper or brass. When installing pipe, use as little compound as possible on the joints, and always blow out piping before connecting it to any equipment. Pipe take-offs should be from the top of tanks, headers, etc. to reduce moisture and dirt carry-over. Locate traps and drains at low points, in the coolest possible places, and make sure pipes have the proper pitch toward these drain points.

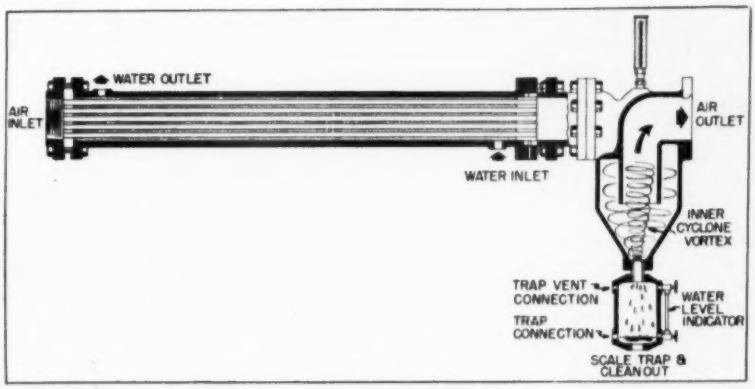



Fig. 3. Section through a pipeline aftercooler used to condense oil and water from instrumentation air

### The Air Compressor

The compressor passes on all the moisture and dirt that comes to it and adds some of its own in the form of lubricating oil, metal particles from cylinder wear, and dirt if the machine is badly maintained. In many plants where oil-free air is required, non-lubricating compressors are used. These are similar to conventional machines, but they have carbon piston rings which do not need oil lubrication. The advantage of such a compressor is that oil does not get into the air system; the disadvantages are that for a given horsepower, the compressor delivers less air than the oil lubricated type, and has to be carefully run to prevent wear on the rings.

Whatever type of compressor is used, it should be big enough to carry the load easily and it must be carefully maintained. Overloading wears piston rings so that oil leaks past them; bad maintenance has the same result and allows dirt and rust to accumulate.

### The Aftercooler

When the air leaves the compressor, it passes through an aftercooler, or heat exchanger, in which the hot compressed air passes over water-cooled coils. Most of the moisture in the air condenses, falls into a trap which is a part of the aftercooler, and is removed as water. Much of the oil vapor also condenses and is removed in the trap. At any particular temperature, a cubic foot of air can hold a certain quantity of water vapor, and any excess will condense. The lower the temperature, the less it can hold, so the colder the cooling water, the more moisture we can squeeze out of the air. Some plants use refrigerated aftercoolers, but this should not be necessary if an ordinary cold water supply is available. The object is to cool the air as far as possible below the temperature of the piping and equipment through which it has to pass on its way to the instruments. If this is done, there will be no danger of its condensing on the way, and when it does get warmer by coming in contact with the piping and equipment, it will be unsaturated at this higher temperature (as explained above, the warmer it is, the more moisture it holds), so it actually becomes a drying agent, and can absorb any stray moisture it might meet on its way to the instruments.

If the plant has an existing air system and no compressor is needed just for the instruments, the aftercooler should be located immediately beyond the point where air is taken from the compressed air mains. Fig. 3 shows a section through a typical aftercooler and trap.

From the aftercooler, the air passes through a filter to remove dirt and oil. A few examples of the many types of filters which are available are shown in Figs. 4, 5 and 6. Some are made of porous stone, some of felt, some of fine woven wire mesh. Once installed they should be inspected and cleaned regularly. Many filters become so dirty through neglect that they actually put dirt into the system instead of taking it out.

### Air Receiver

From the filter, the air goes to a receiving tank where it is stored until needed. The compressor automatically cuts in and out to keep up the pressure in the tank. The receiver should be located in a cool place so that more moisture can condense in it. To prevent accumulation of water in the tank, it should be inspected and cleaned regularly.

A large connection should be used for the inlet pipe to the receiver, to reduce danger of freezing due to throttling action.

All the equipment described so far should be located below the level of the control instruments.

The air in the receiver will be clean and dry enough for most control applications where neither instruments nor piping are liable to freeze, and from the tank it passes to the pressure reducing valves and control instruments.

When the air drawn through the

*(Continued on page 116)*

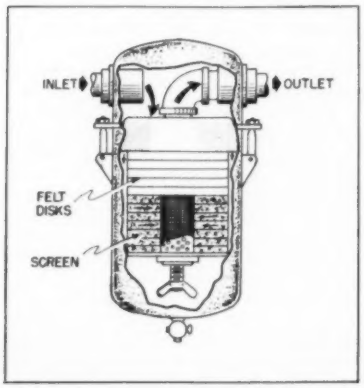



Fig. 4. Section through a felt pad pipeline filter

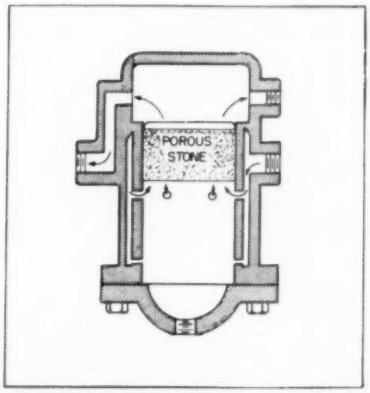



Fig. 5. Shows pipeline filter made of porous stone

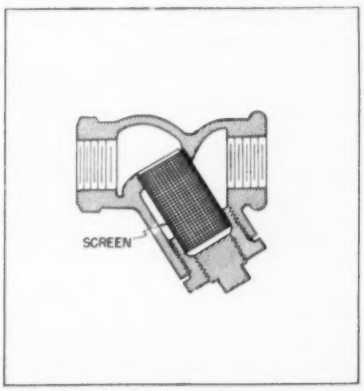



Fig. 6. This filter uses a woven wire mesh screen

# Compactness Features This Air-Conditioning System

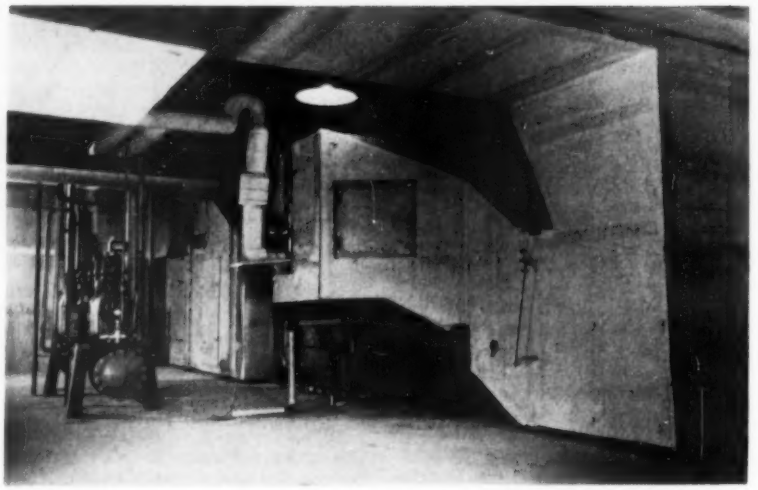
By RAY KINKAID
Dravo Corp.

NEW BRANCH of the Ohio Savings and Loan Co., in the Warren Village Shopping Center, Cleveland, is designed to make banking transactions as easy and as pleasant as possible. The building includes a modern heating and air conditioning system. A temperature of 75 F is maintained winter and summer, with plenty of fresh air being circulated at all times. The system was installed at a cost of approximately $30,000, including heater, cooling equipment, cooling tower, fan, controls, piping, ductwork, wiring, and other essentials. Because many industries, buildings and institutions have air conditioning systems, the details of this system should interest power engineers having to deal with such installations.

Heart of the system is one Counterflo direct-fired gas heater. This was selected in preference to a steam system because it could be fitted directly into the air duct system, and would require little maintenance at much lower cost than steam. It also eliminated the additional cost of providing steam piping, valves, and heating elements.

The heater is installed in a horizontal position in the basement with the air conditioning cooling coil mounted above it, as shown in the photograph. These combined units together occupy a space only 7 ft long, 8 ft 6 in. wide, and 6 ft 6¼ in. high. The heater, cooling unit, fan, air-mixing chamber, and discharge chamber are combined into one complete air-conditioning system.

The building contains a total of 95,264 cu ft, with an estimated heat loss of approximately 500,000 Btu per hr. Yet from October 3, 1951 to May 13, 1952, when outside temperatures sometimes dropped to as low as 9 F, the building was maintained at a uniform, comfortable, 75 F at a total fuel cost of only $417.89 (based on the use of 760,000 cu ft of natural gas at 55¢ per MCF).



General view in basement of Ohio Savings & Loan Co. showing air conditioning equipment. Heater installed horizontally to save space (center), cooling coils above it, fan in plenum chamber to left of it

### Air Circulation

A constant volume of air, heated or cooled as required, is circulated in the building through concealed ductwork, discharging from attractive ceiling diffusers. Two thermostats, one near the stairway to the mezzanine and the other on the mezzanine itself, are set to maintain the desired temperature, which remains the same inside regardless of weather.

Return air from the building is mixed with fresh air in a plenum chamber adjoining the heating and cooling equipment. A fan, powered by a 7½-hp motor, forces the air mixture through either the heater or the cooling coils, depending upon whether the system is on summer or winter cycle.

Two automatic dampers are arranged in the main discharge lead from the duct of the heater, one serving ductwork for the front of the building and the other serving that for the rear. They are interlocked with two similar dampers that serve the cooling coils.

Ceiling diffusers have dampers that permit volume control through the bottom of the grill.

### Equipment Installed

The heater is a 500,000 Btu-per-hr model, of standard design except that the usual blower was omitted and a separately-driven exhaust fan provided. It has a stainless steel combustion chamber, with no refractory lining and allowing a quick exchange of heat, from flame to air, through a single thickness of metal. Its heating efficiency is reported to be between 80 and 85 per cent.

Principal items of the cooling system are:

A condensing unit with a 40-hp motor-driven compressor of the hermetically sealed type. The compressor is mounted on top of the condenser and this assembly is mounted on the floor in front of the heater.

A cooling tower, capable of handling 15,000 cu ft per min, with two fans. The unit has a 150-gpm pump requiring 3.6 bhp, with 66 spray nozzles. The pump has a 5-hp motor drive. This tower permits re-use of cooling water, reducing water consumption by approximately 90 per cent.

A direct expansion coil, consisting of finned tubing with two headers and two distributors, with 27 tubes in each of four rows.

Each of the two room thermostats controls a pair of interlocked dampers serving the ductwork for its part of the building. If warm air is required, the hot air damper at the heater is opened, and that from the cooling coil closed by the same amount. If cool air is required, this action is reversed.

Two additional thermostats are located in the plenum chamber to maintain the required temperature of air there. One thermostat, used in winter, keeps the temperature in the chamber at 82 F. The other, used in summer, maintains the temperature in the chamber at 62 F. To achieve the desired temperature, the proportion of return air to fresh air is increased or decreased, but this is never allowed to exceed 3 to 1. Re-use of a portion of the return air reduces the cost of heating air in winter and of cooling it in summer.

As air enters the system through the cooling coil, the dampers controlling this air energize a relay which starts the refrigeration machinery.

Fresh air is drawn into the system through an 11-in. by 50-in. gooseneck intake on the roof of the building, with a screened opening 4 ft above the roof. Exhaust from the heater is carried through the roof through a vent stack.

Sidney H. Morris and Associates, Chicago architects, designed the building and its heating and air conditioning system. Riester and Thesmacher Co., Cleveland, installed the heating and air conditioning units and Slawson Equipment Co. provided the controls.

Fig. 1. Locomotive Development Committee and L.D.C. engineers inspect rotor blading of coal-burning gas turbine, after its first 750-hr test run


**By JOHN I. YELLOTT**
Director of Research
and
**PETER R. BROADLEY**
Assistant Director of Research
Locomotive Development Committee


# Progress Continues on Coal-Burning Gas Turbine Plant

**Coal-burning gas turbine power plant of L.D.C. completes 750-hour high-temperature test, burning coal exclusively. The test shows performance of ash separator, the condition of turbine blades, operation under the high-temperature and full-load conditions. Much progress made towards getting the practical unit * on the rails**

MAJOR ACHIEVEMENT of the Locomotive Development Committee in 1952 was the completion of a 750-hour high-temperature test of the world's first complete coal-burning gas turbine power plant. Ordered by the Committee from the Allis-Chalmers Manufacturing Co. in 1946, long before the details of coal handling or combustion equipment had been determined, the power plant was installed during 1951 in the Dunkirk plant of the American Locomotive Co.

While the Allis-Chalmers locomotive-type gas turbine power plant was being completed and given its factory tests in Milwaukee late in 1950, the Committee was demonstrating that another gas turbine — a Houdry unit borrowed from the U. S. Bureau of Mines — could be operated successfully with coal, by the direct-fired, open cycle. The Houdry turbine, however, was limited by its blade and casing materials to temperatures below 950 F, and the effects of air at temperatures up to 1300 F could not then be explored.

The 1950 tests of the Houdry turbine showed that blade erosion, the L.D.C.'s major problem, could be prevented by use of a highly efficient multi-tube fly ash separator. A similar but larger separator was then designed and built for the new Allis-Chalmers plant. The installation was completed and the plant was given its acceptance test in September, 1951. Coal-fired operation was immediately undertaken. (See POWER ENGINEERING, July 1951)

### First Coal-Fired Test

The first 178 hr of coal-fired operation of the locomotive-type turbine, in the fall of 1951, showed that the new separator could protect the 4250-hp turbine as long as the in-

* Editor's Note: — As noted in the *Engineers' Preview*, May issue, page 8, column 3, the development work and test results have led to an agreement between American Locomotive Co. and the Locomotive Development Committee of BCR to carry on intensive work on possible commercial applications, especially for locomotives. Alco will carry on the development of the turbine for commercial uses and will design a chassis for locomotive use, and the entire development will be accelerated.

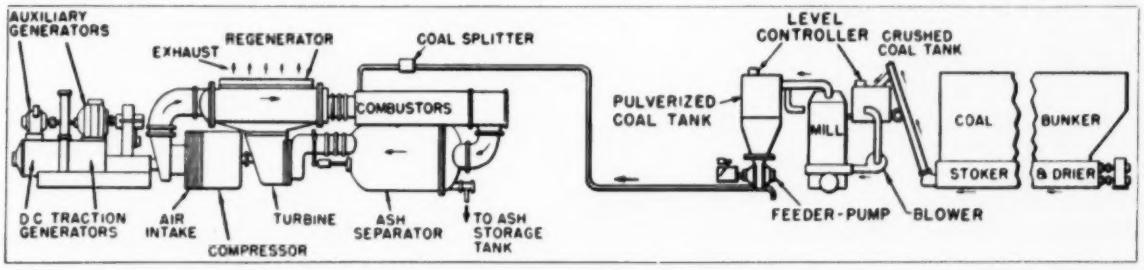



Fig. 2. Shows a diagram of the coal-burning gas turbine power plant as set up ready for testing in the L.D.C. testing laboratories located at Dunkirk, N. Y.

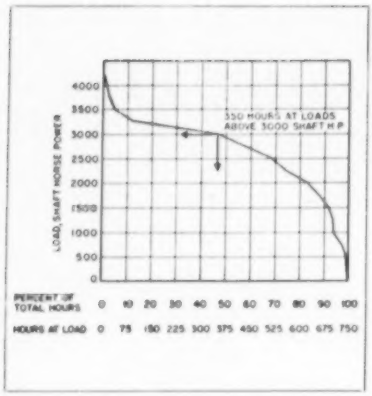



Fig. 3. Shows load duration curve for 750-hr test

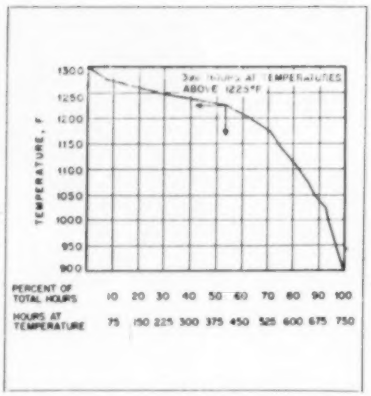



Fig. 4. Temperature duration curve for 750-hr test

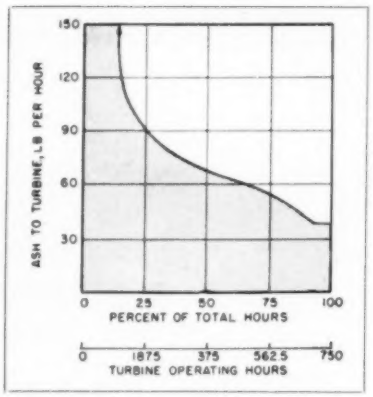



Fig. 5. Ash duration curve for 750-hr turbine test

dividual separator tubes functioned properly. (See POWER ENGINEERING, May, 1952.) This preliminary 178 hours of operation was carried out with the use of a pilot oil-burner in each combustor, and the maximum load carried for any significant period of time was 2000 hp.

The 750-hr test was undertaken to determine the effect upon the turbine and other components of operation for prolonged periods at temperatures above 1200 F, and loads above 3000 hp. The Committee also stipulated that no oil was to be burned during the hours credited towards the 750-hour goal.

### The 750-Hour Test Begins

The 750-hr test began on February 4, 1952. During the first two months of operation the plant reached its rated capacity, 3750 hp, on nine occasions. On March 6, 1952, maximum power of 4250 hp was maintained for more than an hour, showing that coal could fuel the plant as effectively as oil had done in the acceptance tests.

A number of difficulties were encountered during these first weeks of operation. Most serious was a leak which developed within the fly ash separator due to a cracked weld. This leak occurred during the first 70 hours of the test, and it resulted in the passage through the turbine of a large amount of coarse ash. This in turn caused the beginning of the erosion which was found throughout the first five stages when the machine was opened for inspection at the end of the test.

A sampling procedure was instituted immediately after the first 70 hr to warn the operators of the presence of excessive amounts of ash at the turbine inlet. Operation during the remainder of the 750 hr test was regulated by the weight of ash caught in each half-hour period. Whenever the amount of ash thus obtained indicated that the separator was not performing properly, coal firing was halted and efforts were made to clear the separator. If these were successful, coal-fired operation was resumed. If not, the unit was shut down and the separator was cleaned manually.

The test proceeded in a series of 188 periods of varying length — the longest was three minutes short of 24 hours; the average period was 4 hours.

The fuel used was a high volatile bituminous coal from Willow Grove No. 10 mine, Pittsburgh No. 8 seam. Its proximate analysis showed, as received, 4.25 per cent moisture; 7.5 per cent ash; 39.45 per cent volatile matter; 48.8 per cent fixed carbon. Higher heating value, as received, was about 13,210 Btu per lb; effective heating value at 1300 F was 12,200 Btu per lb. The ash softening temperature (oxidizing atmosphere) was 2100 F, and the grindability was 55 to 60 (Hardgrove scale).

### Test Results

The total coal consumption was 2,132,250 lb, at an average firing rate of 2840 lb per hr. The power generated was 2,070,750 hp-hr, at an average load of 2760 hp. The average specific fuel rate was 1.03 lb per hp-hr, giving an average thermal efficiency of 18.7 per cent.

The temperature record showed that the turbine inlet air temperature was always above 900 F while coal was being burned. Maximum temperature attained with coal firing was slightly above 1300 F. Average temperature was close to 1200 F.

Best thermal performance was reached at about 3000 hp, where the specific fuel consumption was about 0.95 lb per hr, giving a thermal efficiency slightly above 20 per cent.

Aside from the separator troubles mentioned previously, the plant operated reasonably well. A number of

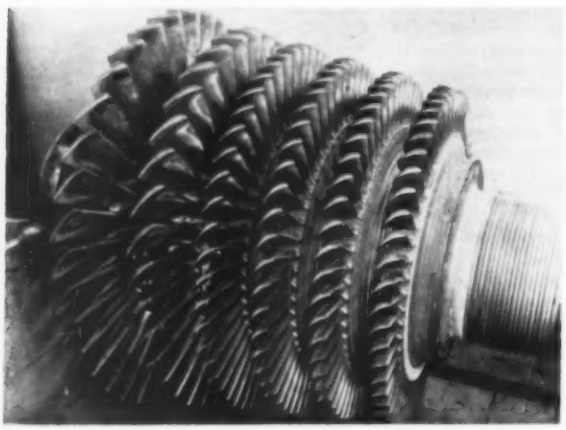


Fig. 6. Coal-burning gas turbine rotor, as seen from inlet side, after 750-hr test reported here. Ash separator passed coarse ash during first 70 hr of test

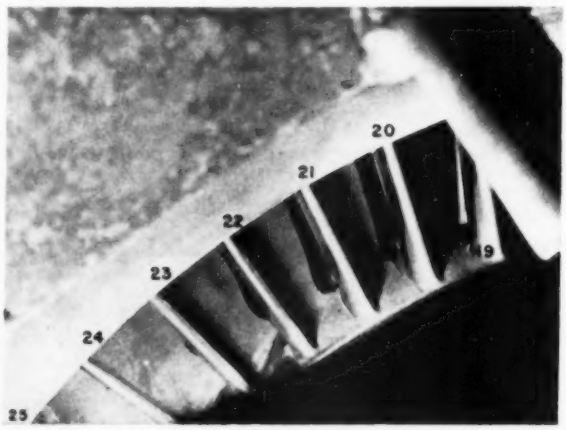



Fig. 7. Portion of first-row cylinder blading as seen through turbine inlet after the first 71 hours of coal-fired test operation as explained in text

forced shutdowns were caused by foreign matter in the coal, which leads to the conclusion that a coal-fired gas turbine locomotive should be supplied with prepared fuel from which all nuts, bolts, railroad spikes and the like have been eliminated.

### Turbine After 750-Hour Test

The turbine was opened for inspection in the presence of the Steering Committee on August 26, and erosion was found in the first five stages of the turbine. This erosion was most evident in those portions of the blading adjacent to the rotor. The damage was undoubtedly due to the excessive amount of coarse ash which had passed through the machine when the separator was not functioning correctly. The last row of rotor blades showed virtually no damage, indicating that the ash had been thoroughly pulverized prior to reaching these blades.

Closer examination of the blading showed that there were no ash deposits of any consequence. The erosion was similar to that encountered in early tests of the Houdry unit, when separator performance had been poor. The test left no doubt that only the best possible separator performance is good enough to protect the blades of a coal-fired gas turbine, and the separator in use during the test did not give the necessary protection.

Other components of the plant did a much better job than the separator, however. The two coal pumps stood up well and showed relatively little abrasion after 181 and 575 hr respectively. Control of feed-rate was satisfactory; a simple fluidizing device at the bottom of the pulverized coal tank eliminated the bridging which had caused so much trouble in the preliminary tests.

Ring-supported combustors were in use for 698 hours of coal-burning as well as 140 hours of oil-burning, and they came through the tests in excellent condition. Combustion efficiency was consistently above 95 per cent, and no oil was burned after the coal flame was established.

### Dust Emission Very Low

One major achievement in the test was the demonstration of a coal-burning power plant for locomotive service which complies with even the most stringent smoke control ordinance. Most ordinances in effect today permit as much as 0.85 lb of dust per 1000 lb of stack gas. The coal-fired gas turbine holds its dust emission below 0.2 lb per 1000 lb of exhaust. The appearance of the stack even at full load was excellent, with only a greyish haze being visible.

The 750-hr test demonstrated that operation of an open-cycle coal-burning gas turbine at high temperature (1300 F) does not differ in any important respects from operation at low temperature (800 F). When fly ash removal is virtually complete for particles larger than 20 microns (approximately 0.001 in.) in diameter, blade erosion is negligible. When coarse ash is allowed to pass through the turbine, erosion follows rapidly. The L.D.C. program is now being concentrated on the remaining problem of maintaining top separator efficiency at all times. There is every reason to believe that this goal will be achieved as a result of the cooperation between the American Locomotive Company and the Locomotive Development Committee.

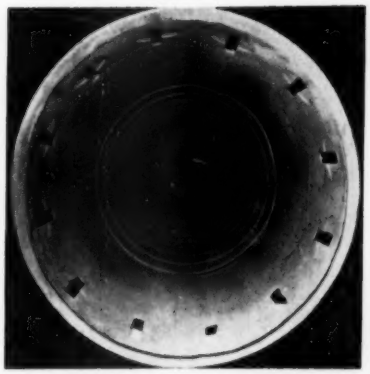


Fig. 8. View of one of the coal-burning gas turbine combustors after 750-hr test burning coal alone

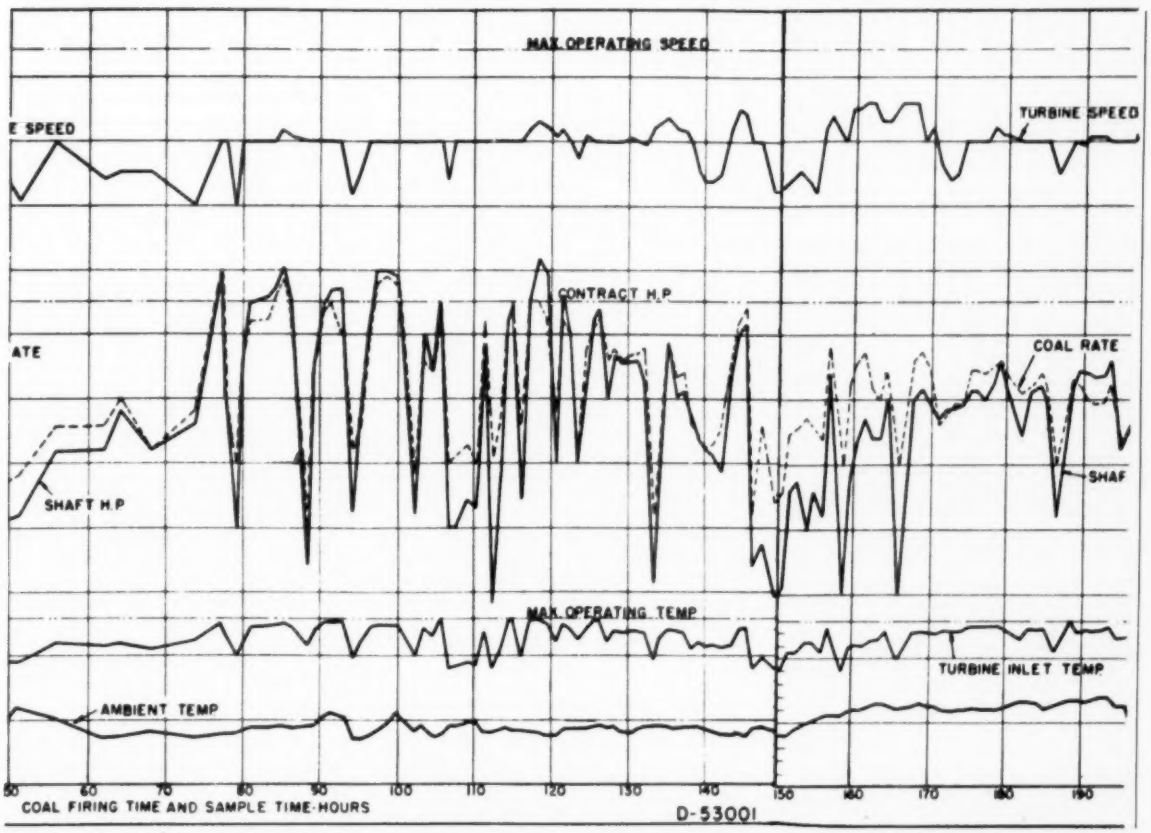



Fig. 9. Part of coal-burning gas turbine 750-hr test chart including operation from 80 to 130 hr when unit exceeded contract hp without reaching full speed

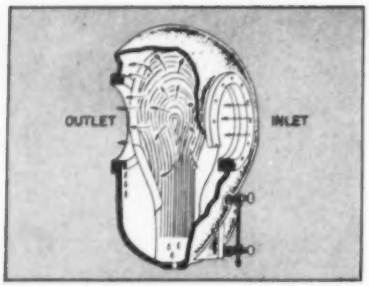



Fig. 1. A water spray wets baffles in this Wright-Austin Separator when used under vacuum

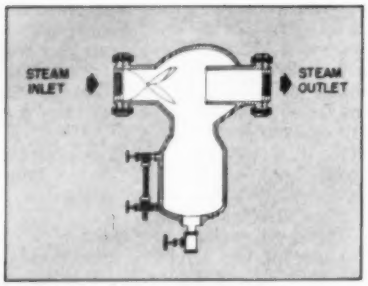



Fig. 6. In the Swartwout Horizontal Separator a helix gives swirling motion to the entering steam

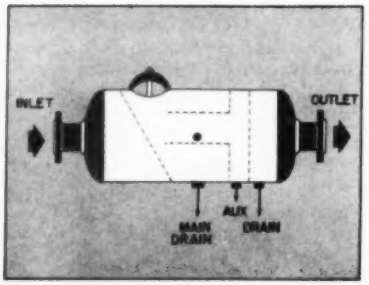



Fig. 7. Cochrane Steam Purifier uses a baffle to deflect water before trapping impurities

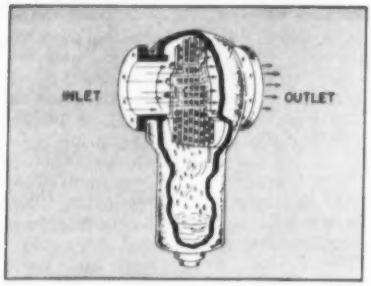



Fig. 2. Cochrane All-Service Separator, ½ to 12 in. for steam and air in horizontal pipes

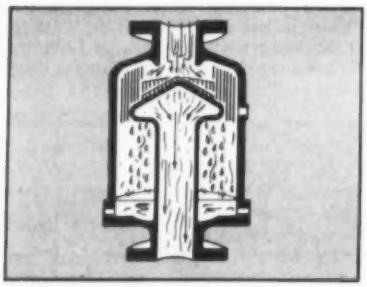


Fig. 3. Cochrane All-Service Separator, 2 to 10 in. for steam and air in vertical downflow pipes

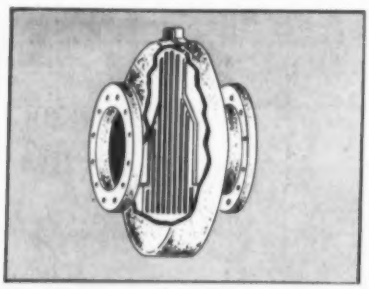


Fig. 4. Cochrane Low-Pressure Separator, 14 to 48 in. for low pressure steam service up to 75 psi

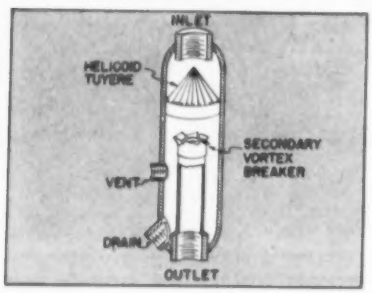



Fig. 5. In this Centrifix Separator for the small lines, a swirling motion is given to entering steam by a "helicoid tuyere". Impurities thrown out by centrifugal force run down the wall of vessel to the drain; secondary vortex action at the outlet pipe is prevented by a device made of a number of irregular lugs. Any oil which creeps up the outer surface of this pipe and reaches the edges of the metal lugs drops off to the drain sump

# Separate Oil from Your

**In this article the author discusses construction and operation of the most commonly used power plant oil-steam separators**

SEPARATING OIL from steam is one of the most difficult of all power plant problems, and it was explained in the July 1952 issue of POWER ENGINEERING how oil carried over in the exhaust from steam engines contaminates boiler and condenser tubes and leads to danger and inefficiency. Where exhaust steam is used in process operations, it is usually essential to separate entrained oil from the steam. In dyeing textile yarns or fabrics, for instance, oil impairs the dyeing process and makes streaks in the finished goods. Heating coils prevent this particular trouble, but require a more expensive piping layout, while an oil-steam separator is less expensive and will give satisfactory results.

### Influence of Oil Type

Lubricating oils are mixtures of hydrocarbons, some of which vaporize at fairly low temperatures. It follows, therefore, that no matter how cunningly the separator is designed mechanically, it cannot eliminate entrained oil if that oil is vaporized at the temperature of the steam. For exhaust steam, compounds such as lard oil and acidless tallow are claimed to offer few separation difficulties, unlike rape seed oil and degras, and efforts have been made to develop a compound which will help cylinder oil adhere to metal surfaces in the presence of steam. A pure mineral oil is easier to separate than fatty oil, since it has a higher temperature of vaporization and does not emulsify as readily. The higher the percentage of compounding and free fatty acid, the more stable the emulsion which the oil will form with hot condensate. This tendency is measured by the demulsibility factor of the oil. If there should be no vaporization, there is frequently a proportion of the oil so finely divided that separation by any method is difficult.

For a condensing engine, a separator in the exhaust line has the merit of removing much of the possible free oil and reducing contamination of the condenser. Of course, the backpressure created by the separator must be considered, and the amount of water separated with the oil may be excessive (anything up to 15 per cent), a serious drawback in marine service, for instance, where the feed make up is drawn from salt water evaporators. For the most efficient separation, the separator should be placed to receive the steam at its lowest temperature. Various claims are made for the performance of oil-steam separators. The reduction of oil content of very oily steam to 3 ppm is considered reasonable by many operators; much will depend on amount of oil vaporized.

The principles of design for oil-steam separators fall under the following headings:

1 — Baffling: The steam is intercepted by corrugated or fluted plates, grids, meshes, etc., to which the minute drops of entrained water and oil adhere and run down to a collecting drain or well.

2 — Flow Deflection: The direction of the current of flow is abruptly changed. This causes the oil and water in the steam, due to their greater density, to be thrown into a receiving vessel while the steam passes on in the reverse direction.

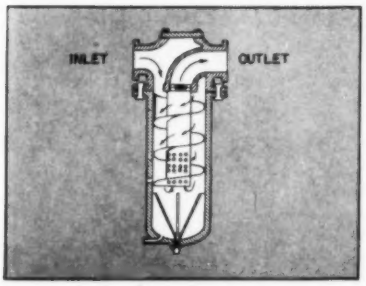



Fig. 8. This Keystone Separator was one of the earliest types of centrifugal separating devices

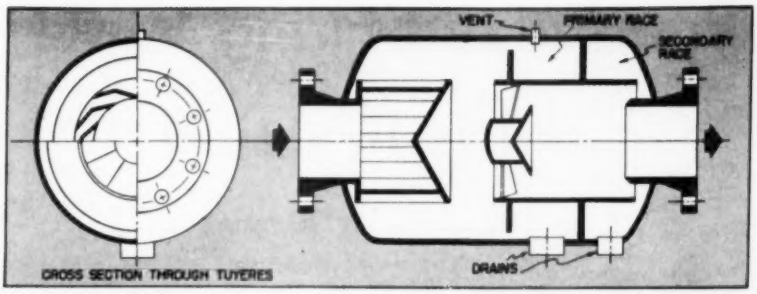



Fig. 9. The Centrifix Separator for large diameter pipes has a specially designed "helicoid tuyere" to give swirling motion to the entering steam so that the impurities are thrown out by centrifugal force

# Steam the Modern Way

By GEORGE S. EMMERSON

College of Engineering, University of California

3 — Centrifugal Force: A swirling motion is imparted to the steam causing centrifugal force to throw out the entrained particles of oil or water.

4 — Adsorption and Filtration: The oil and steam are passed through filters of adsorbent material, screens, or meshes, which hold the oil and let the steam pass through.

One or more of these principles are employed in the various steam separators used in practice.

### Flow-Deflection Separators

Most of the common oil interceptors use the simple principle of baffling. Usually the baffles are made with fluted surfaces of various forms. Sometimes a series of small cups, rasp-like barbs, or recesses, are cast in the face of the baffles. Baffles of this kind are often called "gridirons" and are usually placed in staggered formation in the path of the steam. The moisture in the steam is gathered by capillary action into the cups, which are connected to the hollow interior of the baffle plate by small drain holes. This type of interceptor will eliminate a lot of oil in the steam provided the plates and corrugations remain clean.

The efficiency of separation increases as the velocity of the steam decreases. The first object of design, therefore, is to make the separator large enough to reduce the velocity of the steam (not less than twice the pipe size). The resulting expansion of the steam lowers the temperature and this condenses some of the vaporized constituents of the entrained oil. It has been found that the pressure drop through a baffle-type separator increases as the square of the velocity (Armour Institute of Technology — 1905). If the steam has little tendency to condense and form a film of moisture on the baffles, separation is less efficient. Thus, if separation takes place in conditions of partial vacuum, the steam has little tendency to condense and deposit moisture, so it leaves the surfaces with which it comes in contact too dry for effective separation. In this event, the separating surfaces are sometimes wetted by a spray of water, as in the Wright-Austin separator shown, or alternatively, condensation is induced by cooling the separator with a water jacket. The same problem arises if the baffles are too hot, or if the steam is superheated. Re-entrainment of the separated moisture is an ever-present danger and difficult to prevent in this type of separator when the plant is on heavy duty. All separators of course, must be designed to prevent the separated fluid passing through the steam current on its way to the collecting drain. Particles of water or oil are about 200 times heavier than equivalent volumes of steam at 100 psi (1500 times heavier at atmospheric pressure) and therefore they tend to shoot ahead under the influence of their own inertia when the steam velocity is suddenly reduced, or if the direction of flow is abruptly altered. Thus, for a separator depending upon a whip-snapping action — the "Hoppes" is of this type — the higher the velocity of the steam the better. Objectionable re-entrainment, however, then becomes more likely.

A number of separators are fitted with a patent baffling element or

(*Continued on page 118*)

Fig. 13. Shows the Supreme Vortex Separator, which consists essentially of a ring of fixed admission blades, suitably inclined with convergent passages between them which induce a strong free vortex in separating chamber. Impurities are subjected to an intense centrifugal force that impels them to wall where they flow down in thin sheet to drain. Separator is widely used abroad, and makers claim 99 per cent separation

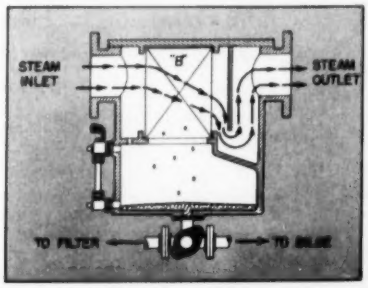



Fig. 10. In North Eastern Interceptor, baffles B subject the steam to a violent buffeting action

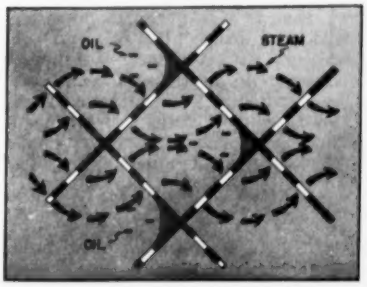



Fig. 11. Detail of one cell of removable baffle element B in North Eastern Interceptor in Fig. 10

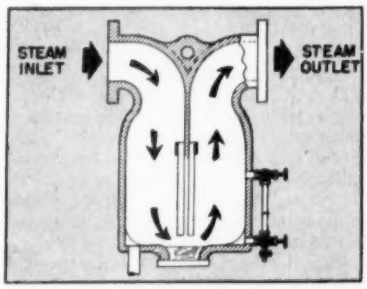
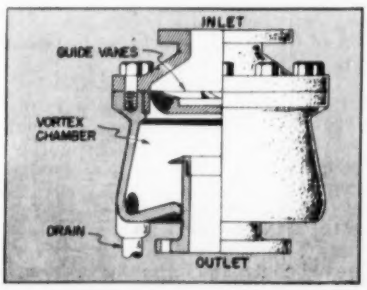



Fig. 12. Hoppes Horizontal Line-Type Separator depends on sudden change of steam flow direction



# Pressurized Firing With Coal Is Practical

By G. W. BICE and W. M. YEKNIK
American Gas and Electric System

**Pressure operation of large pulverized-coal-fired boilers has problems as well as advantages. Construction and operation of 6 such units by AG&E shows that most of the difficulties can be overcome, and most of the advantages realized**

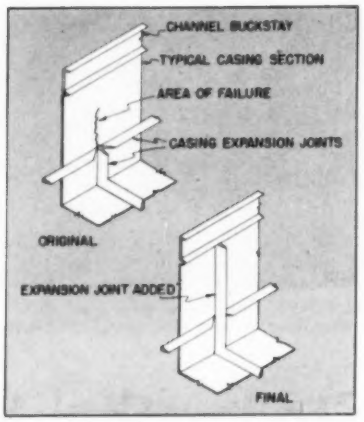



Fig. 1. Lack of proper expansion facilities in economizer casing panel was corrected by the addition of a single-bellows vertical expansion joint

EARLY IN 1946 the American Gas and Electric Service Corp. began design and installation of two 150,000-kw single-boiler compound turbine generators — one for Twin Branch Plant and one for Philip Sporn Plant.

In considering boiler design a study was made of special pressure-tight steel casings to permit operation with forced draft only. This type of operation, with its basic simplicity and economic advantages, has been in use for many years, principally on oil-fired marine boilers, but more recently on small pulverized-coal-fired experimental boilers.

### Numerous Advantages

It was recognized that pressure casing on large pulverized-coal-fired stationary boilers and auxiliaries would present many new and difficult problems; however, possible long-range advantages were so attractive that it was decided to proceed with construction.

Because these units were expected to operate at an over-all average heat rate of 9270 Btu per net kwh — better than system average — their incremental value would make outages of any kind costly. Conventional induced-draft equipment would be provided, but arranged for complete by-passing for pressure operation. It was also believed that, eventually, design of future units could be undertaken safely without induced-draft equipment. A long-range program, its attainment will probably be slower than first projected, and may be postponed until boilers are designed for complete outdoor installation.

The many advantages associated with pressure operation can be divided into three distinct categories:

1 — Those advantages resulting from design of the boiler enclosure itself, and realized during pressure or suction operation: reduced setting leakage; improved superheat and reheat control characteristics; improved control of furnace conditions; and, smaller flue gas outlet equipment.

2 — Those advantages realized only under pressure operation: reduced auxiliary power; reduced auxiliary heat loss; reduced fan maintenance; improved air flow control; and, safer operation during start-up and low-load periods.

3 — Those advantages realized only when the unit is designed without induced-draft equipment: reduced investment; and basic simplification of automatic control system.

There is only one *unavoidable* disadvantage to pressure operation — increased first cost. But there are a number of theoretically avoidable disadvantages in actual design, workmanship and day-to-day operation. Most of these can be minimized by induced-draft equipment — transfer from pressure to suction and vice versa can be done in 2 or 3 min without difficulty, even under full load.

### Avoidable Disadvantages

Some major theoretically-avoidable disadvantages are: limited access through 3-in. diam doors, the largest that can be fitted with aspirating facilities; difficulty with soot and slag blowers; difficulty with rotating shaft seals, especially on primary air fans, louvre dampers, etc.; difficulty with ash and slag removal, especially on slag-tap units; increased coal bunker fire hazard with high-volatile coal; and, dust nuisance, which diminishes after faults and points of inadequate expansion are corrected.

These points were covered by the authors in Paper No. 52-F-32 before the 1952 Fall Meeting of ASME. They then brought out the following major operating details.

There are 12 pressure-operated boilers on AG&E's system, all of which are arranged for pressure and suction operation. All are completely housed except for dust collectors on the 150,000-kw Philip Sporn and Tanners Creek units, and air heaters, dust collectors and forced-draft fans on more recent 200,000-kw units.

Typical of problems and work involved in preparing for pressure operation was installation of boiler 11 at the Philip Sporn Plant.

### Installing Boiler 11

Because of earlier unsuccessful pressure-operation trials at Twin Branch, low-speed forced-draft fan motors were installed. In March, 1950, 4 months after initial operation, several short partial-pressure runs were made with forced-draft fans wide open and induced-draft fans throttled to produce a furnace pressure of about 11 in. of water at 120,000-kw net output. Severe gas leakage and rapid overheating of retractable slag blower wall boxes took place.

During a short outage in September, 1950, high-speed forced-draft fan motors were installed. Renewed attempts to operate under pressure were generally unsuccessful because of leakage through the convection-pass rear wall between the inlet screen and secondary superheater center cavity. An investigation showed the original tube and shaped-tile construction in this area had been seriously damaged by the action of slag blowers about 2½ ft away.

During May, 1951, the lower rear wall was rebuilt using flat studs with pored-refractory backing, rear retractable slag blowers were relocated, and new improved wall box seals were installed on all blowers. After several weeks of operation alternating between suction and pressure, during which time miscellaneous casing and door leaks were corrected, the boiler was placed on regular pressure operation.

Within a relatively short time, failure of the ash hopper water-seal skirt made further pressure operation impossible and it was necessary to return to continuous suction operation. Seal skirt on this boiler was in two parts — the submerged lower two-thirds composed of corrugated

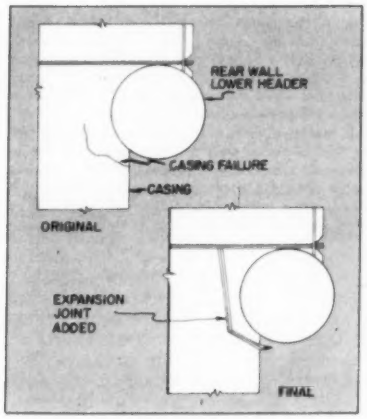



Fig. 2. Differential expansion caused failure in casing just outside of ash hopper seal skirt. Single-bellows expansion joint corrected the failure

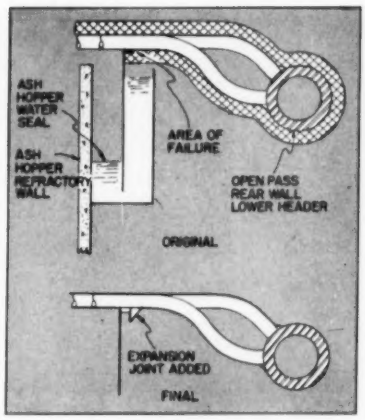



Fig. 3. Failure of tie between lower rear water-wall header and side wall casing was corrected by an expansion joint at approximate line of failure

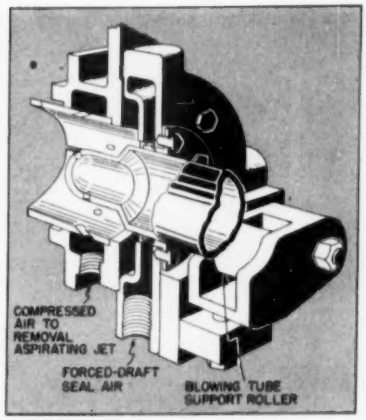



Fig. 4. Rigid wallbox seal with attached blowing tube support roller for full-retracting slag blower. This seal shows promise of solving problems

stainless steel and the dry upper one-third of plain carbon steel. The carbon steel portion had failed from extensive corrosion apparently caused by condensation of sulfurous components of gases from inside the ash pit. Since a corresponding water-seal skirt of single-piece stainless-steel corrugated plates had given no difficulty in a similar boiler, boiler 11 skirts were rebuilt using all stainless steel. After this alteration, the boiler was again transferred to pressure operation.

### Maintenance Required

Pressure operation is now considered normal except for short periods required for maintenance work on pulverizers, slag blowers, and for occasional repair of minor leaks at casing expansion joints and around setting doors. It has been possible on a number of trials to work on pulverizers without changing to suction operation; however, special precautions have been required to seal connecting dampers. This problem is expected to be solved soon by redesign of pulverizer inlet dampers and outlet burner-line gates. In connection with slag blower removal, basic data on compressed-air removal equipment completed in the laboratory has been applied to several blowers in the field, and it now appears simply a matter of time until all blowers can be equipped with practical compressed-air removal equipment.

One other difficulty experienced on this boiler (and on three other boilers), involved removal of relatively large slag chunks which fell into ash pits and could not be moved by sluicing jets as originally intended. Manual lancing was often required to dislodge such chunks. Lancing through small (3-in. diam) air-aspirating doors did not prove practical, so it was necessary to transfer the boiler to suction operation at unpredictable intervals and lance through large access doors. Ash pit bottoms have been revised and sluicing jets relocated recently in order to overcome this difficulty.

System load requirements dictated an accelerated erection schedule which did not permit adequate pressure testing of the setting prior to operation. In the case of the last two Philip Sporn boilers, however, boiler erection was sufficiently ahead of turbine erection to permit one to two weeks of testing.

Actual mechanics of testing required temporary blanking of air inlet ducts, gas outlet flues and all small openings such as fan shaft seals, damper shaft seals and slag blower wall boxes which would eventually be sealed by forced-draft air through an extensive system of seal-air piping. After such closures were completed, internal pressure was built up to about 18 in. of water using a special connection from one of the pulverizer primary air fans, temporarily equipped with a quick-closing blast gate. Time rate of the pressure drop was then measured. Completely unsatisfactory at first, welded casing joints and other possible leakage sources were examined by coating with a soap solution, after which pressure was dropped and all leaking joints rewelded.

### Remedies Applied

Figures 1 through 3 show how three failures, which showed up during operation but not during the initial testing, were remedied, through redesign.

This procedure was repeated until a satisfactory pressure drop rate was obtained. For the tested boilers this was 5 in. of water pressure drop (from 18 in. to 13 in.) in 20 min. This was calculated to be equivalent to 140 cfm leakage, most of which probably occurred around temporarily sealed slag blower wall boxes, damper shafts and similar openings. Until testing was completed, no insulation was applied to areas of possible leakage.

To appreciate the tremendous effort to get complete tightness, it must be remembered that the total envelop subject to leakage on the boiler is approximately 45,000 sq ft. Obviously, very careful planning is required to establish satisfactory erection and testing sequence for the pressure boiler unit.

### One Sealing Problem

One interesting problem involved sealing full-retracting slag blower wall boxes.

The seal on the first blowers was based upon sealing a close-clearance annulus, formed by the blowing tube and a concentric spring-loaded sliding plate, with forced-draft sealing air. Satisfactory in some respects, this seal had to be abandoned because of excessive clearance, initial poor fit and warping of the outer seal plate, and pulling apart of the sealing plates against the springs because of blowing tube fouling and misalignment.

Next, a segmental cast iron outer seal, held together by a small garter spring, was added. This seal proved unsatisfactory as the segments tended to be pulled out of place by the blowing tube on its return travel, and also wore itself as well as the blowing tube excessively.

Next seal developed consisted of two parallel close-clearance annuli, connected rigidly by a sealing air chamber, and fastened to the wall box proper by a short length of flexible metallic tubing. This seal at first appeared to be entirely satisfactory; however, after several months it too developed several weaknesses.

At the same time, a completely different seal was designed. This seal employed multiple unrestrained close-clearance rings. Altogether five seals of this type were installed, but maximum life was about 3 months with severe gas leakage and blowing tube wear occurring during the last month.

Two more seals are now under development (Fig. 4 shows the most promising one), with an experimental model of one installed on a blower.

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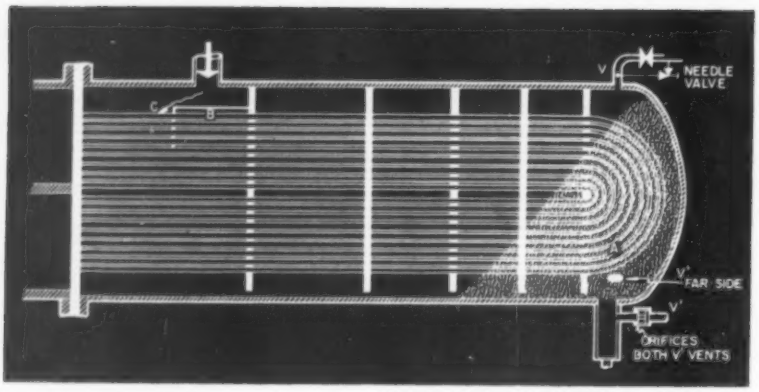


Fig. 1. Horizontal, two pass, bent tube closed heater, single steam inlet, longitudinal flow, sinuous. Baffle: Saddle type made from perforated steel plate. Comments on baffles in Fig. 3 apply here also. Vents: At top of shell as at "V". Heavy gases will pile up as shown by shaded area "A". Two low level vents with orifices should be added at "V'". One on shell prevents sealing if one in sump is temporarily flooded. Same remarks about drainage apply to vertical units. Drainage: Single drain pot should be used at dead end of shell. Multiple drains may act as steam by-passes

# Rehabilitating Feedwater Equipment

**When old equipment becomes inadequate, it is often cheaper or quicker to rehabilitate it instead of buying new replacements. Here the author discusses various troubles sometimes overlooked and suggests ways in which they can be eliminated by improved design**

**By C. W. BELL, Sr.**

Engineering Consultant

FOR THE PURPOSE of this discussion, rehabilitation of equipment is an extension of normal maintenance.

Some of the reasons for rehabilitation are:

a — To catch up with advances in design;

b — To take advantage of newer and more suitable construction materials;

c — To alter equipment to suit new operating conditions;

d — To make modifications, conventional or not, to offset previous irregularities and improve serviceability.

### The Problem

When new equipment is hard to get it is important to find ways to keep out-dated equipment in service, and to do it without incurring serious operating penalties. Also, competition demands better performance than was originally expected from old equipment.

In feed water circuits, constantly improving standards of chemical treatment and the resulting purer steam require changes in metals from time to time, particularly in tubes and tube sheets.

### The Alternatives

When old equipment becomes inadequate, the first thought is to replace it with new. However, it might be cheaper or quicker to modernize the old to do as good a job as new equipment. Rehabilitation can vary from minor repairs to a complete rebuild, and the amount of work to be done on any piece of equipment has to be decided by financial analysis. Some of the factors which have to be considered in such an analysis are:

1 — Availability of equipment or material — how long must the work wait.

2 — Outage time for actual work.

3 — Expected life when the work has been done.

4 — Cost — immediate and per year.

5. — Relationship of this equipment to associated items which may control its usefulness.

6. — Relative Responsibility — will cycle stop if equipment fails — what damage will occur if cycle operates without it — what economic loss would be incurred — is the heat cycle involved increasing or decreasing in importance. Not much time or effort should be used to improve items that will soon become inactive or even peak loaders.

### Maintenance Records

No sound evaluation of equipment can be made without an accurate record of its maintenance history and an equally accurate record of its operating performance.

Maintenance records for tubular heaters, condensers, etc. always require a diagram of the tube sheets with each tube indicated in a numbered row and column pattern. (Fig. 2.)

After the first few tubes have failed due to faulty workmanship or flaws a pattern of concentration of deterioration will emerge. This pattern will indicate the possible life of tubes if all bad local conditions are remedied. Most modern heating installations have enough measuring devices for accurate records; older plants may need extra thermometer wells and thermometers which were not provided when the equipment was installed.

Some situations may call for different tube materials in selected zones in cross flow designs. This can sometimes be done in straight tube units as a maintenance procedure and delay the day for complete tear down.

To determine the tendencies sample tubes should be removed — say once a year — one tube from each of the suspected zones. These tubes must be brought out as carefully as possible, marked to identify the top side, and carefully charted as to "column" and "row". Any tubes that actually fail must be identified with equal care.

Whenever a tube fails it may cause impingement damage on neighboring tubes — the position and direction of leak will show where to expect additional failures — sometimes it is good judgment to remove the suspects at once.

Whenever any tube is removed the adjacent inside surface of the tube sheet should be examined (dental mirror suggested) and its remaining thickness measured. Notes should be made too of all damage done to the bore of tube holes.

### The Signals

In a simple cross flow unit, flow down, severe corrosion in the lower zones is an indication of stagnant oxygen and $CO_2$. (Fig. 3 — Area A)

Etching of steam side surfaces and possible signs of cracking in the upper part of tube banks calls for checking for ammonia gas. (Fig. 3 — Area B)

Where the direction of flow is other than down these zones will appear in different positions. (Fig. 2 — End view)

High velocity steam impingement may show up by local eroded areas.

High velocities of steam through the entrance rows to tubes may cause vibration damage at any tube support plate and if the tube spans are long, they may scuff each other. Vibration also crystallizes tube metal adjacent to rolled ends and speeds up fatigue failure.

There is always a pressure differential through a tube bank. This may be very low as in small cross flow units or a matter of a few psi in a full counter flow design. Excessive leakage past baffles not only interferes with performance but can do much damage. The same is true at tube support plates if the pressure gradient is high. Very critical examination is required to detect some of these unhealthy signals.

### Design

With an ideal design no zone or part would be subjected to bad deterioration so that wearing parts would have maximum service life. At the same time materials would be selected to give maximum service for the lowest over-all cost, which would include the indirect cost of outage time as well as all direct maintenance costs.

The well established open pattern now used for steam condenser tube layouts is not yet in general use for smaller heat exchanger units but the same principles apply. The direct thermal benefits are not impressive for heat exchangers and in most instances the pressure differentials are not important. The criterion here has to be serviceability. This factor doubtless needs more consideration.

The tendency to write *average* temperatures and loads into specifications should be cross checked in each situation since critical conditions are most frequently met in the abnormal or subnormal ranges of operation. For instance low water temperature may cause sufficiently high steam velocities to destroy the normal protective surface film and cause short service life.

High temperatures speed up deposition of metal — "dezincing", etc.

Though the following suggestions are for rehabilitation beyond the range of routine maintenance, there is no clear cut division between the two.

Observations made during regular maintenance outages as well as the results of all special tests and investigations should be carefully recorded and reviewed once or twice a year. Any deficiencies or irregularities can then be charted and a well co-ordinated plan prepared for corrective action that will eliminate the trouble.

The following examples of deterioration are quite common. Causes and cures are suggested. References are to Figs. 1, 2, and 3.

Trouble: — Severe corrosion in zones commonly remote from steam inlet.

Cause: — Usually stagnant $O_2$ and $CO_2$, due to inadequate or incorrect arrangement of vents. (Area A)

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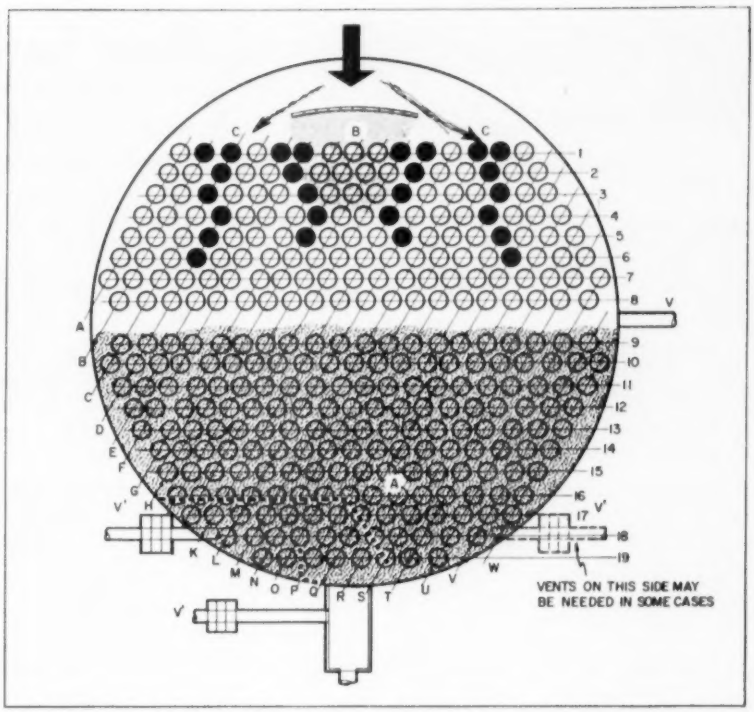


Fig. 2. Triangular pitch tube sheet layout for two pass, straight tube, down flow condenser or heater. Steam Baffles and Drainage: Comments on baffles and drainage in Figs. 1 and 3 apply here also. Vents: Unhealthy concentration of heavy gases in shaded area "A" where high level vents — side "V" or top alone are used. This area shifts off center when a side steam inlet is used. Low level vents as at "V'" will reduce destruction of tube metal and improve operation. Air baffle of type shown by dotted line along tube 16 with its companion bottom barrier can be beneficial. Laning suggested by plugged tube holes in upper tube bank (2nd Pass) will relieve tube vibration by giving steam direct access to more tube surface. Sometimes performance may be improved by extending such lanes well into the lower tube bank

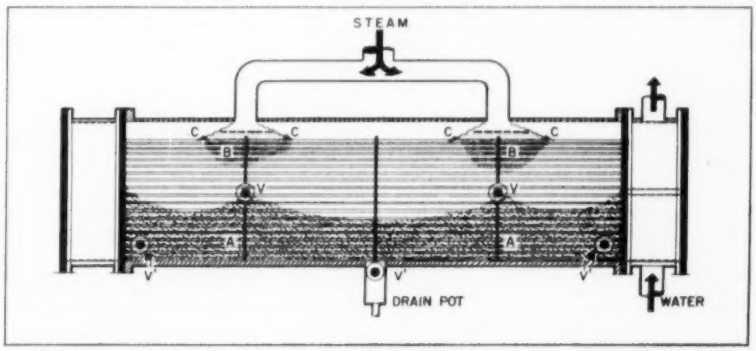


Fig. 3. Two pass, straight tube horizontal closed heater, double steam inlet, cross flow down. Baffles: Solid plate, tend to cause stagnant pockets of light gases "B". If too small, high velocity steam may erode tubing at "C". Perforated plates with holes ¼ in. to ⅜ in. for impact area and ½ in. to ¾ in. for outer surface will improve steam distribution. Vents: Placed half way up shell are inadequate for either light or heavy gases. Most of noncondensables are driven to point furthest from steam inlet, shaded area "A". The area of concentration varies. Main vents should be at low level as at "V'". If high level gas pockets still exist special probe type vents may be added. Drainage: Should be below all the tube surfaces, to maintain not over 2 in. max depth of water in the shell, except where drip cooling features are incorporated. When the multiple drains are used they should be connected to zones of definitely equal pressure

# Concrete Setting Must be Controlled

**This shows how concrete sets, and how a catalyst controls setting time, prevents cracking, and makes concrete more compact**

ALL CONCRETE MIXES are fundamentally the same — sand and stone glued together with a cement-water paste. If the glue is weak, adding more glue will not make it stronger — the only way is to use a stronger glue.

If cement grains had only to be suspended in water to make a paste, the quantity of water required could be calculated precisely. Unfortunately, when water and cement are mixed together, they react chemically to form a paste, and, like most chemical reactions, this one is affected by temperature. In hot weather the cement takes more water than is good for it, with the result that concrete placed in hot weather develops more cracks and less strength than when placed in cold weather. If we can control this greed for water, so that at each temperature the cement takes just the right amount, we will get concrete that is equally strong for all placing temperatures.

Catalysts, such as Plastiment, which accelerate or slow down this rate of absorbing water, are available. For more information write to the editors, POWER ENGINEERING.

Here are explanations and diagrams showing what happens when cement and water are mixed together, and shows how the reaction will be controlled by adding the catalyst.

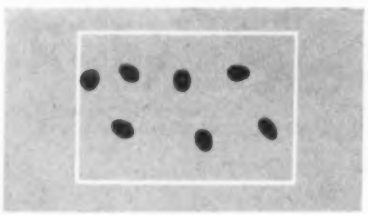

**Fig. 1. Shows a mixture** of dry sand, aggregate and cement, with the cement grains shown as black dots. The main constituents of cement are lime, silica and alumina. When mixed with water, chemical action takes place, turning it into a glue which binds the sand and aggregate together to form concrete. The action taking place when cement and water are mixed is shown in these diagrams.

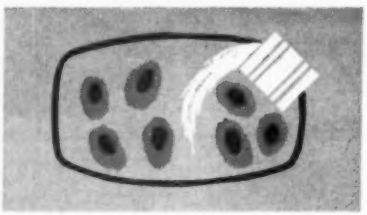

**Fig. 2. When cement and water** are mixed, the surface of each grain of cement absorbs moisture and swells to form a gel layer. This gel is like household gelatin, and it gives freshly mixed concrete its familiar fatty appearance. Cement grains absorb water freely and the more water available the larger will be the gels. Water is needed to make the gels, and acts as lubricant for whole mix.

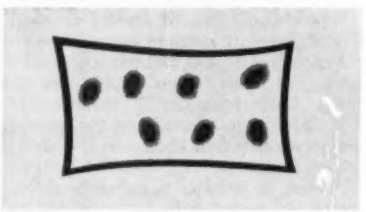

**Fig. 3. During hardening,** the gels crystallize, and when dry, they revert back to their original size. But by this time the mix is no longer plastic, and the larger the contraction of the gels the greater will be the stresses due to shrinkage. Therefore the less water we have to use the smaller will be the gels, the less they will contract when setting, and the smaller will be the danger of cracking the concrete.

**Fig. 4. In hot weather,** gels form so rapidly that they steal water from the rest of the mix, and more has to be added for working. This extra water has two bad results: the mix becomes weak because the water-cement ratio is too high, and the gels grow too large and crack the concrete when they contract. Also, the heat generated by rapid gel action in hot weather increases the cracking stresses.

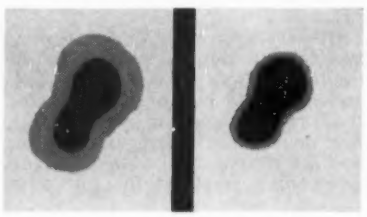

**Fig. 5. Shows a comparison** between a grain of ordinary cement which has absorbed too much water and grown too large, and one which has been prevented by the presence of a catalyst from absorbing more than the proper amount of moisture. When the gels are small, less water is needed for gel formation and more is left for working the mix. Also, there is less contraction when the gels crystallize.

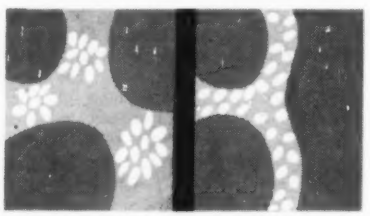

**Fig. 6. When the gels are small** there is less tendency for them to flocculate, so they become distributed more evenly throughout the mix, giving greater compaction and more uniform adhesion. Also, thin gel layers transmit vibration much better, giving a closer compaction with less opportunity for the segregation caused by large stones sinking to the bottom and all the fines floating to the top.

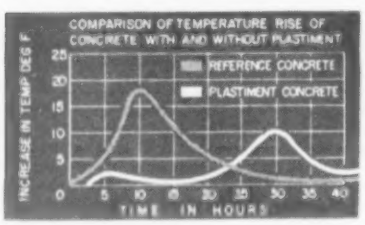
COMPARISON OF TEMPERATURE RISE OF CONCRETE WITH AND WITHOUT PLASTIMENT
REFERENCE CONCRETE
PLASTIMENT CONCRETE
INCREASE IN TEMP DEG F
TIME IN HOURS

**Fig. 7. Shows concrete temperature** changes with and without gel control.

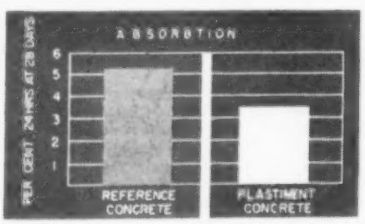


**Fig. 8. Shows water** absorbed by concrete with and without gel control.

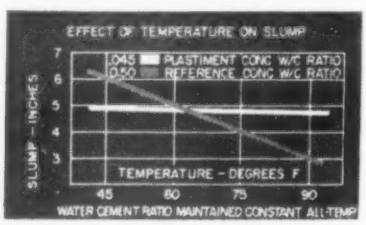
EFFECT OF TEMPERATURE ON SLUMP
.045 PLASTIMENT CONC W/C RATIO
.050 REFERENCE CONC W/C RATIO
SLUMP - INCHES
TEMPERATURE - DEGREES F
WATER CEMENT RATIO MAINTAINED CONSTANT ALL TEMP

**Fig. 9. Gel control** makes slump nearly independent of temperature.

Power Engineering's

# PRACTICAL ENGINEER and ELECTRICIAN SECTION

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What the Power Engineer Needs to Know About

# Centrifugal Boiler Feed Pump Maintenance

**First he needs to know: "What is the right time to open and overhaul pump—at regular intervals or only when evidence of trouble appears?" Author favors latter procedure, tells why. Future articles will tell how to keep all pump parts in proper condition for uninterrupted service at lowest cost**

**By I. J. KARASSIK**
Manager, Multistage Pump Section,
Centrifugal Pump Division,
Worthington Corporation

ONE OF THE MOST controversial problems of centrifugal boiler feed pump maintenance concerns the frequency and periodicity of complete overhauls. Some operators hold that a pump should be opened for inspection and overhaul at regular intervals, generally once a year or, at most, every two years. Others prefer to open up a pump only when evidence of the need for an overhaul appears. The author is committed to this second maintenance rule, for the following reasons:

1 — Cost of a complete overhaul is generally high and should not be incurred unless necessary.

2 — Unit being overhauled is unavailable for service if an emergency arises;

3 — Every overhaul introduces possible hazard of faulty reasembly and hence possible failure;

4 — Modern designs and practice in material selection permit long uninterrupted service;

5 — Simple means are available to the operator to determine actual need for inspection and complete overhaul.

### Why Open the Pump?

There are two entirely distinct reasons why a pump may need to be opened up. The first is linked with severe, and generally sudden, trouble caused either by the presence of foreign matter in the waterways of the impellers or of the pump casing itself, by severe corrosion or erosion attack on the pump parts due to the use of improper materials or by mechanical troubles, such as severe vibration or even seizing of the rotating parts due to cavitation, overheating or similar causes. The second reason, obviously a more general one, is that internal wear has resulted in an increase in internal leakage losses such that the falling off of the pump performance makes it imperative to restore the clearances to their original values.

In the first category, the troubles are, in all cases but one, self-evident and require no further discussion. The exception is related to corrosion-erosion troubles, which are not necessarily immediately reflected in the performance characteristics of the pump but which, if permitted to continue unattended, may easily end in damage to the equipment beyond any possibility of salvage and repair.

### Corrosion-Erosion Effects

Such corrosion-erosion troubles are becoming fairly rare in today's steam power plant, because of the great amount of attention devoted within the last decade to proper selection of boiler feed pump materials for high pressure and high temperature service and of the resulting greater use of stainless alloys for both pump casings and internal fittings. However, since ordinary materials are still being used in many low and medium-pressure service units, corrosion-erosion troubles are still foreseeable in such installations. Handling feedwater with a pump built at least partly of ordinary cast iron and bronze may lead to severe and rapid deterioration of the pump if the feedwater is corrosive, so it is logical in such cases for the operator to open the pump for inspection fairly soon after initial operation and at frequent intervals thereafter, until he has ascertained the approximate life of the pump materials under the actual operating conditions. On the other hand, if the feedwater is handled by a pump made of materials which experience has shown have a life of say 5 to 10 years, a yearly inspection is certainly not warranted and he needs only concern himself henceforth with the effects of internal wear.

### Internal Wear

As to internal wear, it becomes necessary to familiarize oneself with its effects on the pump performance. It is a common belief that the wear that takes place at the running joints of a centrifugal pump causes a reduction of efficiency. This, of course, is only a half-truth, as will become apparent immediately. As long as we are considering only the wear at the running joints and assume that no internal leakage has taken place between stationary joints and no serious erosion of the impellers or casing waterways has taken place, the impellers still handle the same gross capacity against any given head and consume the same amount of power in so doing.* However, as the running clearances increase with wear, a greater portion of the gross capacity handled by each impeller is short circuited through the running clearances back to a lower pressure stage. In other words, the effective, or net capacity delivered by the pump — at a given head — will be decreased

* It will be further assumed that suction conditions are adequate, so no reduction of capacity can be attributed to insufficient net positive suction head.

**Editors Note:—Centrifugal boiler feed pump maintenance has received plenty of attention in the technical literature. These pumps are very important in the modern power plant; they perform under constantly-growing severity of service; and there is constant need for training new maintenance personnel. These factors make it necessary to review frequently the problems of maintenance, so as to re-evaluate ideas and practices that may have become obsolete through changes in pump design and manufacture. Such reviews should be presented to power plant personnel even at the risk of repeating data they already possess.**

**Consequently, Mr. Karassik has reviewed a number of his previously-published articles on the subject in this and other magazines, and now presents an up-to-date revision of these data, prepared especially for POWER ENGINEERING, in the form of six short articles. These cover:**

**I—What's the Right Time to Overhaul Your BF Pump?**
**II—What Routine Maintenance Should Be Done?**
**III—How to Give the BF Pump a Complete Overhaul**
**IV—How to Maintain Impellers and Wearing Rings**
**V—How to Maintain Bearings and Packing**
**VI—Operating and Inspection Records and Spare Parts**

**The present article is the first of these; the others will follow in future issues.**

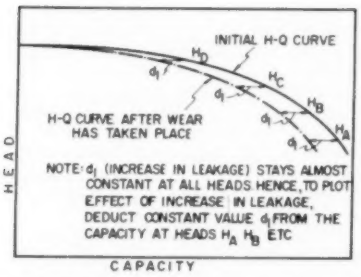

INITIAL H-Q CURVE
H-Q CURVE AFTER WEAR HAS TAKEN PLACE
NOTE: $d_1$ (INCREASE IN LEAKAGE) STAYS ALMOST CONSTANT AT ALL HEADS HENCE, TO PLOT EFFECT OF INCREASE IN LEAKAGE, DEDUCT CONSTANT VALUE $d_1$ FROM THE CAPACITY AT HEADS $H_A$ $H_B$ ETC
HEAD
CAPACITY

Fig. 1. Effect of wear on H-Q curve of the pump

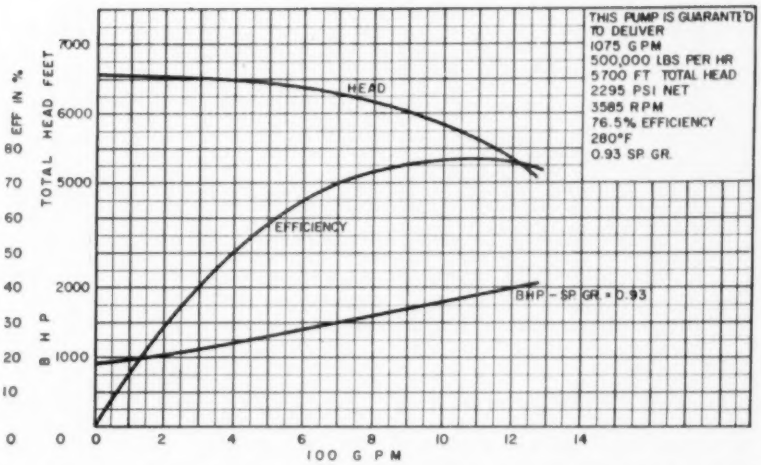



Fig. 2. Performance curves for a typical boiler feed pump; effects of wear are calculated in the text

by the amount of increase in leakage. Inasmuch as the power consumption for a given gross capacity (that is, at a given total head) remains the same, while the net capacity is reduced, the effective efficiency of the pump is reduced in proportion to the increase of the short circuit losses.

Theoretically, the increase in leakage will vary with the square root of the total head. Actually, this variation is negligible: for instance, if the pump was subject to an increase in leakage of 3 per cent at the design head and if the head at shut-off is 115 per cent of the design head, the increase in leakage near shut-off would be 3 × square root of 1.15 or 3.22 per cent, a difference not subject to correct measurement. Practically, therefore, it is sufficient to assume that the leakage increase, expressed in gallons per minute, is the same at all heads. Effect of the increased leakage on the shape of the head-capacity curve is illustrated on Fig. 1.

### How to Evaluate Changes

To evaluate the effect of such changes on the performance of a given boiler feed pump, consider Fig. 2. When new, the pump will deliver 1075 gpm against a head of 5700 ft and will absorb 1880 hp when handling 280-F water, with a resulting efficiency of 76.5 per cent. If we now assume that wear has increased the internal leakage by 3 per cent of the initial net capacity, the pump will only deliver 1043 gpm against the same head of 5700 ft and still absorb 1880 hp. The efficiency will have been reduced by the ratio of 1043 to 1075 or to 74.2 per cent. If, on the other hand, we were concerned with capacity only, the total head which the worn pump develops at 1075 gpm will have been reduced from 5700 ft to 5600 ft and the power consumption will have increased from 1880 to 1903 hp. The net efficiency will have been reduced to 74.2 per cent.

A boiler feed pump is generally selected with an appreciable excess margin of capacity, therefore will develop considerable excess head at the normal operating capacity when operating at full rated speed. In the pump of Fig. 2, for instance, the normal maximum load on the pump may be of the order of 450,000 lb per hr (or 970 gpm) at which capacity the required total head may be only 5400 ft. It becomes apparent, therefore, that in such a case an increase in internal wear of 3 per cent will not have rendered the pump unsuitable for further operation and the decision on complete overhaul at this point will depend strictly on the evaluation of the reduced economy of operation against the cost of the overhaul.

### How to Test Clearances

From these considerations, it becomes apparent that if a test of the boiler feed pump is carried out at regular intervals, it will give a reliable indication of the state of the pump as far as internal clearances are concerned. It is true that it is not always possible to have an accurate venturi located in the pump discharge. However, a calibrated sharp-edged orifice is amply accurate for the purpose, since relative changes in flow rates need be detected rather than exact absolute values.

If a full head-capacity test is not practical, several other means are available to approximate the internal conditions of a boiler feed pump. For instance, an operator can train himself to detect increases in power consumption for a given rate of flow in order to ascertain whether or not renewal of internal clearances is required. Another means is based on the fact that a boiler feed pump develops excess pressure under normal operating conditions. This excess pressure is throttled by the feedwater

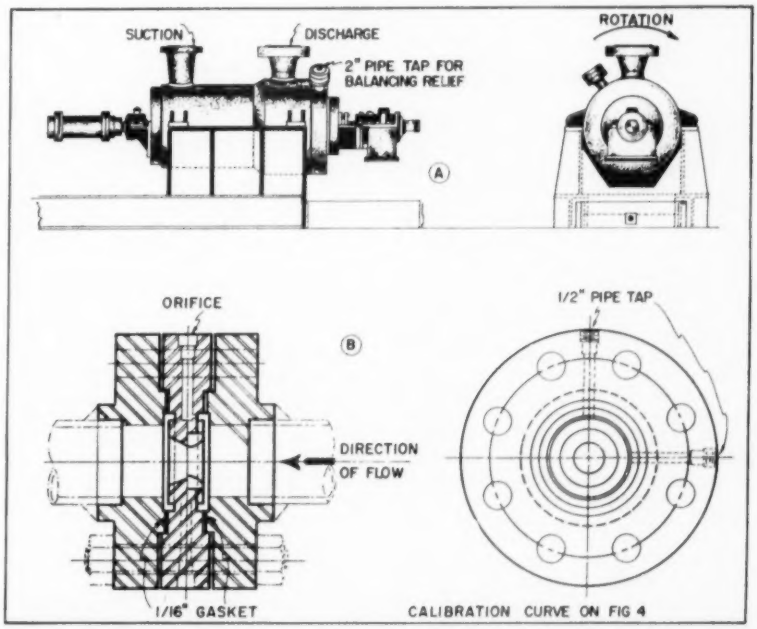



Fig. 3. A — Centrifugal boiler feed pump equipped with balancing device, showing how calibrated orifice may be installed on leak-off line for checking leak-off quantity. B — Orifice installed on pump above

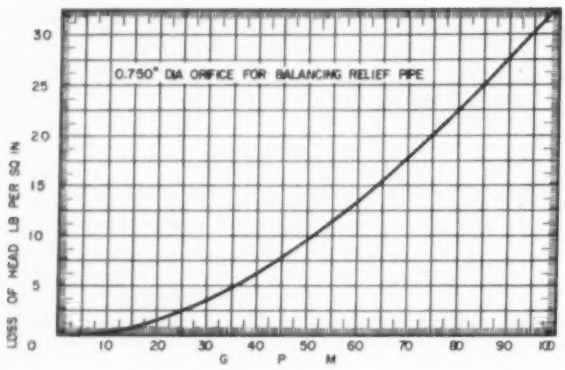



Fig. 4. Calibration curve for 0.750 in. diameter orifice for use in the balancing relief or leak-off line as shown in Fig. 3

regulator if the pump is operated at constant speed, while a variable speed pump will meet the actual required head and capacity conditions by operating at a reduced speed.

Changes in the amount of excess pressure throttled at the regulator or changes in the operating speed for a given rate of feedwater flow are therefore reasonable sources of information with regards to the alteration of the pump head-capacity curve after wear has taken place, and can be used as a guide to the need for overhaul in the same manner as a complete head-capacity test.

When the boiler feed pump is equipped with a balancing device, a check can be maintained on the quantity of the balancing device leak-off by installing a calibrated orifice in the leak-off line, as shown on Fig. 3, with a differential gage or manometer to indicate the pressure drop across the orifice. Use of this orifice in conjunction with the calibration curve, Fig. 4, will give a very accurate indication of the condition of the balancing device while the pump is in operation. It can also give an accurate indication of condition of other internal running joints, by inference.

This inference is derived from the following: the wear of a running joint is not so much a function of the pressure differential alone as of the pressure drop per unit of length; in other words, of the pounds per square inch per inch of joint. The truth of this statement becomes apparent when one compares the life of an orifice ¼ in. long subject to 1000-psi pressure difference and of a ¼-in. pipe one mile long subject to the same differential.

If the design is such that the pressure drop per inch is of the same order of magnitude for the wearing rings and for the balancing device, the life of both parts is of the same order of magnitude and the rate of wear of the internal running joints can be estimated by the rate of wear in the balancing device. Since the increase in the rate of flow past the balancing device is a direct function of the increase in clearance area, reading of the balancing device at any given time is a direct indication of the clearances in that device at that time.

For example, if after 50,000 hr of operation the balancing device leak-off has doubled, it is probable that the clearances in the wearing rings have likewise approximately doubled.

Finally, an approximate check of the internal rotor clearances can be carried out without dismantling the pump entirely. First, all external restrictions to the rotor movement must be removed. This includes the packing, water shields and bearing covers. For sleeve bearing pumps, the split bearing bushings must be lifted out. If the pump is fitted with ball bearings, the bearing housings must be completely unloosened from the casing bearing brackets. The rotor is now moved up and down gently, preferably by hand so as to feel top and bottom contact, and the total vertical movement at each end is measured by using a dial indicator over the outer shaft nuts or some similar exposed part of the rotor. This measurement, of course, will only give an indication of the minimum internal clearance, but it may be assumed that running joints with similar pressure differentials will all wear more or less evenly.

But while a complete overhaul should not be considered as a periodic maintenance practice and takes place only when the need for it arises, there are certain routine maintenance precautions which should very definitely be carried out as routine operations. These will form the subject of the next article.

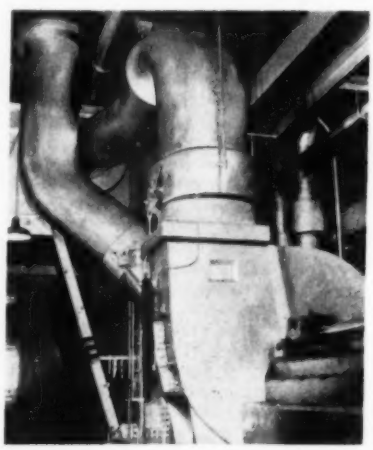
## Insulating Flat and Curved Surfaces

THE VARIETY OF FLAT, curved and irregular heated surfaces of auxiliary power plant equipment has too often resulted in an equal assortment of insulating materials and application techniques. Total insulation cost is then unnecessarily high because installation time is long and materials are purchased in uneconomical quantities. Engineers at the 170,000-kw Glenwood Power Station of the Long Island Lighting Company have reduced installation cost by specifying a versatile combination of insulation and application method that has produced efficient insulating performance on virtually all such surfaces.

In the photograph, a primary-air fan housing and two circular ducts serving Glenwood's boiler No. 3 are all covered with two-in.-thick mineral wool blanket insulation and insulating cement. Secondary air (left-hand duct) at 550 F is tempered with ambient air drawn in at the rear of the fan housing and then delivered at 150 to 200 F through the duct above the housing to the mixing tee. The regular curved surfaces of the ducts and the flat sheet-metal fan housing are insulated with one layer of 24 x 48-in. blankets followed by a one-in. thickness of mineral wool insulating cement applied in two coats.

The insulating blankets, with wire netting on the inside surface and expanded metal lath facing on the outside, are impaled over 3½-in.-long 9-gage galvanized wires welded perpendicular to the surface on about 8-in. centers. The blankets are tightly butted together and laced on all edges with 16-gage wire, and the ends of the welded wires are bent over into the metal lath. The first layer of insulating cement is trowelled into the expanded metal lath, and allowed to dry before the second layer is applied. Two coats of aluminum paint complete the insulation.

The duct flanges are insulated with built-up layers of insulating cement alone. Note in the photo how the cement has been smoothly shaped on the flanges to join the adjacent insulation on the duct. The fan nameplate in the foreground was left in view simply by cutting the blanket insulation and shaping the cement around the nameplate.



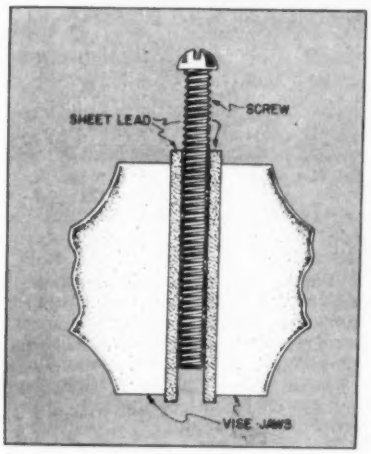
Air fan housing, 2 circular ducts serving boiler

# PRACTICAL HINTS AND KINKS

How about the gadget you made or the trick you used to do your job better? Write us about it. Send a sketch too. You will be paid well for contributions.

## Sheet Lead Protects Threads

BY JOHN FOSTER

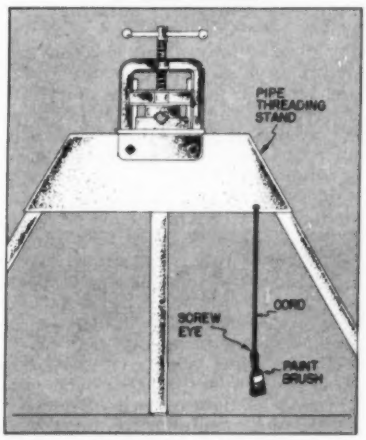



Sheet lead protects screw threads from vise jaws

WHEN IT IS necessary to clamp a screw securely in a vise by the threaded portion, yet avoid damaging the threads, simply place it between two pieces of sheet lead, as shown.

## Pipe Threading Brush

BY CARL THOMAS



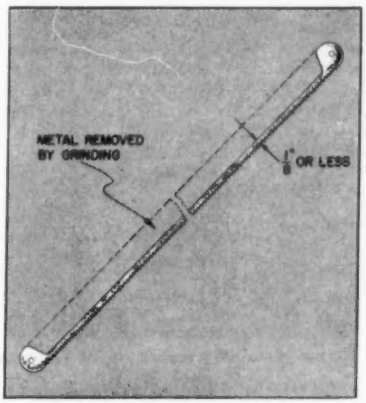

Paint brush, tied to stand, for brushing away chips

AN INEXPENSIVE paint brush, attached to a pipe threading stand or bench with a cord or chain, as shown, is very convenient for brushing metal chips from pipe threads and threading dies.

## Making Intricate Cuts in Metal

BY THOMAS TRAIL

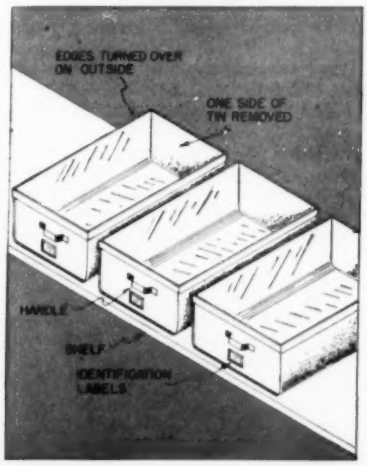
WHERE INTRICATE curves, angles and other cuts must be made in metal, a 32-tooth hacksaw blade, ground narrow as shown, stretched tight in the hacksaw frame will make such cuts easily. Keep the blade cool with water while grinding it to prevent drawing the temper.




Hacksaw blade, ground narrow, simplifies cuts

## Handy Stock Containers

By THOMAS TRAIL



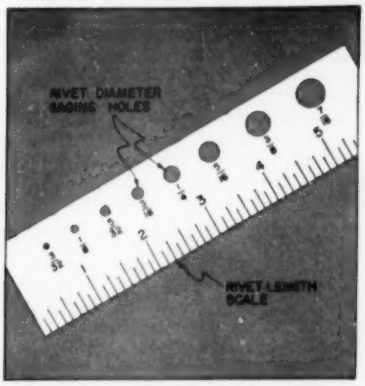

Empty 5-gal tins can be useful to hold spare parts

EMPTY TINS, up to 5 gal in size, when cut to shape as shown, make convenient containers for repair and replacement stock parts, especially if they have a handle already attached. Thinness of the metal of which they are made permits maximum use of shelf space.

## Homemade Rivet Gage

By THOMAS TRAIL

A HANDY GAGE for checking diameter and length of rivets can be made easily, as shown. A flat strip of steel or other metal about 6 in. in length is fitted with a row of drilled holes. Each hole is the diameter of a size of rivet. Chisel marks cut in one edge of the metal strip serve to measure the length of rivets. Holes and inch marks can be identified by stamped numerals or otherwise marked on the metal surface.

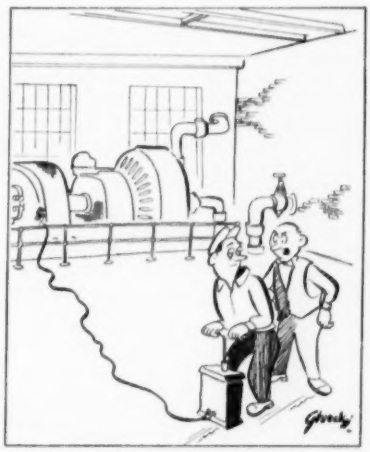



Metal strip, drilled, marked, is handy rivet gage

## Electric Heater Aids Cold-weather Engine Starts

DIESEL ENGINES used in cranes, switch engines and other equipment used outdoors can be kept ready to operate in the coldest weather safely and automatically with electric heat. A few kilowatt-hours of electricity can save many man and equipment hours ordinarily lost in waiting for engines to warm up.

Three cranes and a switching engine at Buffalo Slag Co. are heated economically and efficiently with electric circulation heaters. These heaters are attached to the engine block with angle iron as in the photo. With flexible connections to the cooling system, regular types of anti-freeze are circulated by natural convection through

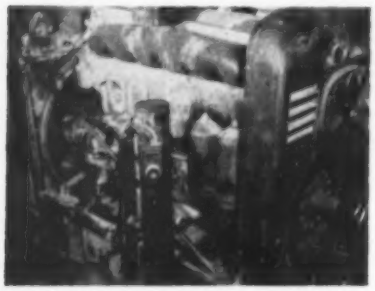


"You sure that's the only way to remove that cover?"

## THE PRACTICAL ENGINEER AND ELECTRICIAN

the heater and engine block, warming the engine in a short time. Special pumps are not required.

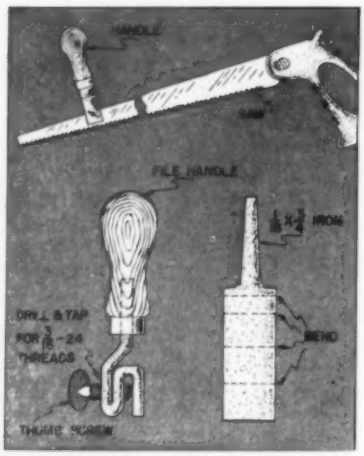
The electric circulation heater shown here is a completely "packaged" unit with built-in elements, heating chamber, thermostat, and threaded inlet and outlet. On average winter mornings a 150 F setting is sufficient to heat most engines in a half hour. In colder weather the heaters may be run all night at 90 F.



Electric circulation heater warms up crane engine

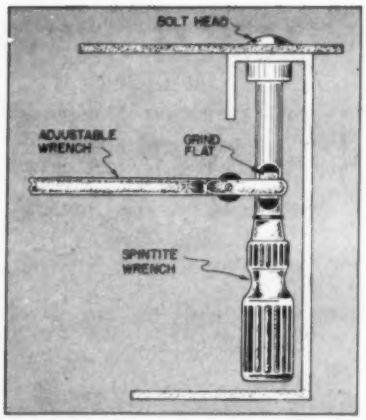
### File Handle Becomes Saw Handle

By CARL THOMAS




File handle converts a keyhole saw for rugged use

A SIMPLE HANDLE, made as shown in the drawing, can be clamped to the blade of a compass or keyhole saw to help steady the blade and apply pressure at the same time.




Two flats provide grip for wrench to aid turning

### Turning a Spintite Wrench

BY THOMAS TRAIL

BY GRINDING two opposite flats on the round shank of a spintite type wrench, as shown, a small adjustable wrench may be conveniently employed to turn the spintite wrench for loosening and tightening bolts and nuts in confined locations.

# Questions and Answers

Your fellow engineers will answer your power engineering questions. You answer theirs, get paid well. Simple? Effective? Why don't you try it!

**Question No. 507**

### Expansion Joints vs. Expansion Loops?

WE ARE LOOKING for some data which would compare the economics of corrugated expansion joints and pipeline expansion loops for steamlines. We feel the subject is of sufficient interest that someone has already made a survey on the subject; perhaps some back issues of POWER ENGINEERING which I overlooked may have this data. We would appreciate any information, reference or leads on where we might look.

Our plant steam conditions include 30-psi, 175-psi and 900-psi steam.

New Martinsville, W. Va. P. R. O.

**Answer No. 506**

### What Can He Do About This Coal Silo?

**Line It, Hudson Suggests**

IN SEVERAL INSTANCES where spontaneous ignition has occurred in coal silos, the trouble ceased when the discharge gates were made airtight by gaskets so that air could not filter upward through the coal. Coal cannot ignite unless air passes through it. Of course, if the silo is small and air can enter from the top, it is possible for it to circulate downward along the wall and upward through the central section.

The best way to protect deterioration of the wall is to place an inner lining of expanded metal and on it a sand-cement-lime facing. The outside can be protected by a similar facing.

Recently on the West Coast silos have been constructed of ½-in. plywood. It would be an interesting experiment to sheath the outside face of the hollow tile silo with a zone of plywood suitably protected by paint, and ascertain whether it is effective. The cost is very low.

Chicago, Ill. W. G. HUDSON

**Suggestions from Wayne**

IT IS WELL KNOWN that coal will ignite by itself if sufficient oxygen or air is present when the ambient temperature rises. It is for this reason that coal stored on the ground is compacted by a bulldozer or other means to keep the air voids to a minimum. Coal pile temperatures are taken regularly to determine if the temperature approaches that which causes self-ignition.

When coal is stored in a silo, the weight of the fuel will compact the pile to a limited extent only, since it depends on the mass and does not have the benefit of compacting from an outside source. This does not keep the air spaces at a required minimum. If air is free to leak into the silo through broken tile, self-ignition of the coal will take place.

JGS states that two fires had occurred within the silo and the tile is deteriorating rapidly. With the tile failing, air is free to enter the silo from the outside leading to a potential fire hazard.

It is suggested that JGS consider emptying the silo, replacing any broken or cracked tile and point up all joints to prevent air entering the silo. This is an expensive undertaking, since it involves not only the material and labor costs for performing this job but also loss of the silo for coal storage while this operation is being performed.

It would be well to receive quotations from a contractor for performing this job and compare with the cost of replacing with a new structure. It may be that the cost of a new structure will not be much greater and give a better silo, eliminating the problems now being experienced.

It is further suggested that JGS analyze the fuel for its chemical constituents to determine if certain elements such as sulphur combined with water and surface moisture of the coal to form acids which deteriorate the tile and mortar. Sulphuric acid ($H_2SO_4$) and sulphurous acid ($H_2SO_3$) will destroy certain tiles, cements and mortars. A competent chemist will be able to make this analysis and determine if either of these acids are present in concentrations high enough to cause this trouble. Mortars and cements resistant to acid attack are available.

It is further suggested that JGS install thermocouples inside the silo

to indicate when the ignition temperatures are approached. A cooling system may be employed using a thermostat which will pass water to the stored coal and lower the temperature to an acceptable value. The system may be automatic and will function when this temperature reaches a certain value or give an alarm which will advise the operator to operate the system manually.

Brooklyn, N. Y. H. B. WAYNE

**Answer No. 505**

## How Much Steam to Heat Molasses?

**Buxton Figures It**

WE MADE a test recently on a sample from a shipment of Cuban black strap and found the Brix to be about 80 deg and the specific gravity to be about 1.39 at 60 F. No test was made for specific heat but, estimating the sample to be a 50-per cent sugar solution (30 per cent sucrose, 20 per cent invert sugar, 30 per cent gum residue, and 20 per cent moisture) I would place the specific heat at about 0.72. This figure, I believe, is near enough for the average black strap from Cuba and has proved to be a reliable one.

Then, for a temperature increase of 50 F:

$$\text{B.t.u. per hr} = \frac{1 \times 10^6 \text{ lb} \times 0.72 \times 50}{10 \text{ hr}} = 3.6 \times 10^6 \text{ B.t.u. per hr}$$

Unfortunately, molasses caramelizes at a relative low temperature — about 250 F for the lighter grades. To be safe, I don't believe you can exceed 230 F if you want to avoid an expensive coil cleaning job. This condition limits steam pressure to 5 psig. (Some engineers believe it should not be heated with anything but water.)

The steam required to heat this batch is:

$$\frac{3.6 \times 10^6}{960} = 3750 \text{ lb per hr (at 5 psig)}$$

V. G.'s boiler is to operate at 125 psig and, allowing a conservative 5-per cent loss to pipe and reduce, the unit must be capable of producing about 4100 lbs per hr or the equivalent of 118 boiler horsepower.

The heating coils are to be of iron pipe, submerged in the unagitated molasses. I don't believe you can expect to get a better coefficient of heat transfer than 15 B.t.u. per hr per sq ft per degree temperature difference. Molasses is very viscous at 50 F; it cannot relieve itself of entrapped air resulting from pumping or the gas resulting from fermentation; natural circulation just doesn't exist in the normal sense of the word.

The logarithmic mean temperature difference existing between the coil and the molasses is 150.4, so the area of the coil required is:

$$\frac{3.6 \times 10^6}{15 \times 150.4} = 1.59 \times 10^2 \text{ sq ft}$$

If we use standard 2-in. pipe for this coil it would require 2,500 ft. For best results, this should be a vertical coil with a steam header at the top and condensate header at the bottom. Of course, if the liquid is stored in more than one tank or cistern, the heater sizes in each would be in proportion to the volume. If V. G. is using a large vat, this heater might be made of several flat coils placed at different levels in the molasses.

May I inject here a suggestion that will place this problem on a more practical basis? Could it not be arranged to heat this molasses as it is used, maintaining the original condition of V. G.'s to heat the 500 tons in 10 hours? The attached sketch is only one method.

Install a pipe coil or suction heater in the bottom of the tank. This heater should have about 100 sq ft of heating surface and will serve the additional purpose of greatly reducing the suction head on the supply pump over what it would be with 50 F molasses. Such a pipe coil should give us an average coefficient of about 40 B.t.u. per hr per sq ft per degree TD and the molasses will leave storage at about 60 F.

On the discharge side of the pump, install a multipass molasses heater having no less than 325 sq ft of heating surface. This heater area is figured using a U of 60 B.t.u. per hr per sq ft per deg TD, which is a reasonable figure providing the tubes are not allowed to foul due to caramelized molasses resulting from overheating. We are now able to supply the required 50 tons per hour at a temperature of 100 F.

In addition, I suggest a circulating return line to the pump suction to provide (1) a pressure relief path for the positive displacement pump in addition to the relief valve on the head and (2) a method of bringing cold molasses left in the line up to process temperature after a shutdown.

Still a third suggestion would be to avoid the use of the inefficient tank heater entirely by heating the molasses as it is unloaded into storage, using the same type of multipass heater as described above. Pumping molasses in large volumes, such as required in unloading operations, is no easy job.

By using any of these suggested layouts, we have not of course reduced the boiler horsepower required to do the job. Probably it should actually be increased to about 125 bhp to allow for the additional losses and the required steam to start up such a heating system. We have, however, reduced materially the investment in heating coils and, what is more important, have installed them outside where they can be maintained at a fraction of the cost over that required to properly maintain such coils inside a liquid storage tank or cistern.

St. Louis, Mo. KENNETH W. BUXTON

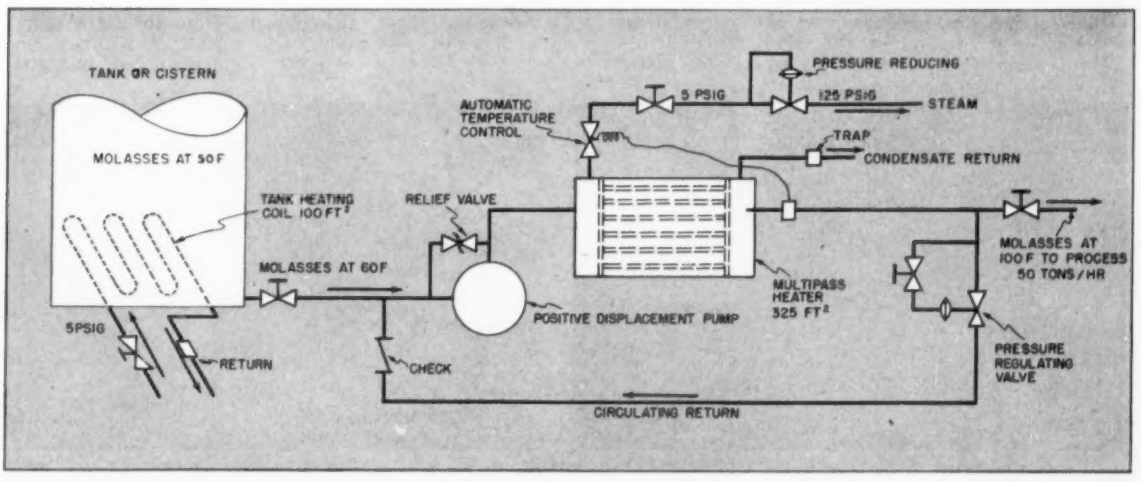



Diagram by Buxton showing suggested arrangement of tank and external heaters for heating molasses so it will be delivered at a temperature of 100 F.

# Lathe Tips for the Power Plant Machinist

By F. E. RILEY

**Few power plant lathes are used often enough for operator to learn tricks of trade that come with frequent practice; yet maintenance jobs have to be at least as accurate as production work, and must often be done in a hurry. Here are some ingenious tips to help the occasional machinist improve his speed and accuracy**

SOME MAINTENANCE departments employ men full time on certain machines so that they become experts in the handling of the engine lathe or universal milling machine, for instance. Other shops do not have sufficient work to keep specialized workers fully employed on certain machines and it is noticeable that much more time is taken to perform machine work in this type of shop.

Most full time machinists acquire considerable skill in working any of the machine tools in a shop and it is reasonable to assume that the difference in speed of work between the specialist and the general machinist is due to the former's wider knowledge of "tricks of the trade". Intensive practice of lathe work, for instance, brings to light many short cuts and slick methods which enable the lathe operator to do his work with less fatigue and in a shorter time. It is with the object of presenting a few of the short cuts used by the skilled lathe worker that this article is written. By adopting some of them, the general machinist in the small maintenance department can achieve a degree of skill approaching that of the specialist. The examples given do not, by any means, exhaust the possibilities of making lathe work easier but they do indicate lines of approach to the solution of the various little troubles encountered in lathe operation in most power plants.

One of the practices which the specialist lathe operator tries to avoid is off-setting the tailstock for taper turning. The main trouble associated with this practice is the difficulty of setting the tailstock back in line, after the taper turning job has been completed, so that shafts can be turned parallel between centers. The more accurately head and tailstock centers are aligned the more confidently and quickly can the operator produce accurate diameters.

### Re-aligning the Centers

When tapers are very long, however, the operator must, despite his objections, off-set the tailstock for the job since a very long taper can be machined by using the longitudinal power traverse of the machine. Off-setting the tailstock accurately will eliminate a lot of "cutting and trying" and one way of doing this is shown in Fig. 1. A short section of rule "A" is secured to the base casting of the tailstock so that the upper movable half of the tailstock can be positioned accurately by setting the mark on it against the graduations on the rule. In lathes manufactured about 50 years ago, this rule or a set of equivalent graduations, was a standard fitting on many machines. There is a tendency to dispense with it nowadays; however, it is worth reviving, as it makes possible a more accurate degree of off-set than by using the common method of holding a rule across the head- and tailstock center points.

Re-aligning the centers after taper turning can be accomplished in two ways. One is illustrated at "B" in Fig. 1 and consists of placing a mark on the heads of the screws which are used for off-setting the top half of the tailstock and a corresponding mark on the tailstock casting. The marks are made when the lathe centers are aligned for parallel turning and the screw at the back of the tailstock is treated in the same way as the one at the front. After the taper turning work has been completed, the tailstock casting is set roughly central by means of the calibrations on the rule "A" and the final setting is obtained by re-aligning the marks on the adjusting screw heads with the corresponding marks on the casting. In this way, the tailstock can be quickly reset within about 0.001 in. of the correct position.

A test for the perfect alignment of the lathe centers is illustrated in Fig. 3. The method consists of nipping a common razor blade between the head- and tailstock center points. If the points are the slightest amount out of line the razor blade will be held at anything but a right angle to the machine center line. Perfect alignment of the center points is indicated by the razor blade sides making a perfect right angle with the lathe center line. It is interesting to note that if the center points are only five-thousandths of an inch out of line it is impossible to nip the razor blade between them.

Both the above methods of re-aligning centers can be performed quickly and are time-saving techniques which eliminate taking trial cuts on the work and measuring with a micrometer while making final adjustments to the tailstock screws.

### Faceplate Removal

General repair work calls for a lot of chuck and face-plate mounting and dismounting from the lathe spindle nose, and operators without much experience make a lot of fuss about

Fig. 1. Small piece of rule "A" on the tailstock base and the marks "B" on the adjusting screw make the realignment of lathe centers easy and accurate

Fig. 2. The white marks warn the operator when the cross slide is nearly disengaged and T-slots make table an extremely useful piece of equipment

this simple task. The threads of the face plate and spindle nose are generally locked together before removal and it is necessary to give them a quick jerk in order to loosen them.

The slow method of doing this is to hold a bolt in place in one of the face plate slots by means of a nut and then to reverse the running direction of the spindle so that the bolt strikes a piece of steel placed on the rear slide of the lathe bed. On small lathes, there is no necessity to go to all this trouble as the simple method shown in Fig. 5 is just as effective and is not likely to damage the machine. A standard double-ended wrench is selected whose thickness is such that it fits neatly into one of the face plate slots. The lathe spindle is locked against rotation by engaging the back gear. A quick jerk of the wrench will loosen the plate on the spindle so that it can be screwed off by hand.

On larger lathes, a special tool can be made up to take the place of the wrench but arranged to work on the same principle. A length of flat bar steel has a piece of plate welded to one end, the thickness of which fits closely into one of the face plate slots. The piece of plate is used the same way as the wrench illustrated in Fig. 5. A special tool of this type takes very little time to make but can save the busy lathe worker much fatigue.

An adjustable wrench can be used for removing small chucks from the spindle nose. The wrench jaws are arranged to span the thickness of one chuck jaw. The outer end of the wrench is given a quick jerk which loosens the spindle nose thread. Larger chucks can be loosened by means of the special tool described for use with face plates. The tool is reversed, end-to-end and the plain portion is placed in contact with the chuck body face so that it spans the gap between two diametrally opposed jaws. A jerk on the outer end of the tool will loosen the chuck.

### Chuck Jaw Reversing

Chuck jaw reversing is another tedious and frequent task called for in general machine work. It can be speeded considerably by fitting to the chuck key handle a crank knob as shown in Fig. 4. The knob has an axial hole which engages with a pin fitting into a hole drilled across the diameter of the chuck key handle. The knob enables the chuck key to be rotated rapidly and knocks several minutes off the time taken to reverse the four jaws of the average chuck. This method can be adopted for changing sets of jaws on scroll chucks.

An alternative to the knob is to fit a new chuck key handle one end of which is bent up at a right angle to form a crank. Yet another method, for use with small chucks, is to use a common carpenter's hand brace with a piece of square section rod gripped in its chuck. The square section material fits into the square recess in chuck screw or pinion.

When machining large diameter work, it is a common accident for the operator to crank the cross slide out too far so that the cross slide screw becomes disengaged from its nut. If the slides are adjusted to fit tightly, it is a tedious and irritating task to push the slide back so that the screw and nut re-engage. Often, the operator has to slacken off the cross slide gib adjusting screws in order to be able to push the slide back.

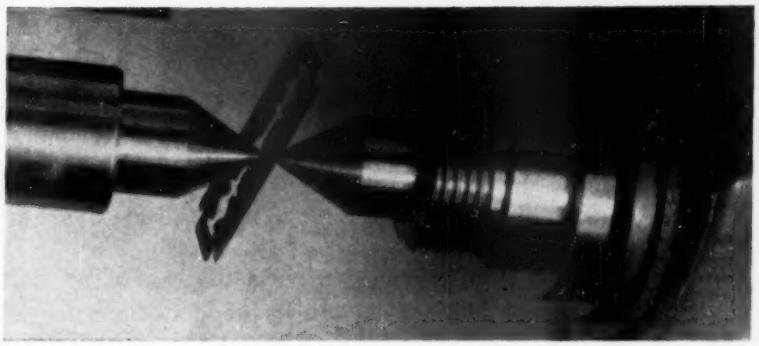


Fig. 3. If centers are more than 0.005 in. out of line the razor blade cannot be held at right angles

### Cross Slide Disengagement

The accident of screw and nut disengagement can be avoided if a clearly visible line is painted on both cross slide and saddle, as shown in Fig. 2. The two lines are arranged to join one another just before the screw disengages with the nut so that time wasting accidents are avoided.

### Cross Slide Improvement

Incidentally, readers may be interested in the lathe cross slide construction shown in Fig. 2 which will be seen to have a flat machined top with T-slots machined in it. The compound slide rest can be removed easily from the cross slide by removing a pair of bolts thus leaving a clear T-slotted table which is one of the most useful lathe refinements ever designed for general machine shop work. Jobs can be clamped to the table top for hole boring with a bar between centers. Face milling can be done on work which is too large to be chucked, by mounting a fly-cutter or face-milling cutter on the lathe spindle. A permanent upside-down parting off tool can be mounted in a block at the rear end of the table and is always ready for use and the mounting for it is much more solid than would be possible with it in the normal top-slide tool post. The cross slide is a standard fitting on one make of small lathe but the writer has had new slides made on the same principle for much larger machines.

Operators should be on the alert to see how they can improve the performance of their machines. There is a tendency to think that because a new machine has many improvements over older models it cannot be improved still further; yet many of the most radical improvements in design hâve originated in the machine shop, and the occasional operator often sees things which may be missed by the man who spends his whole time on one machine.

These simple kinks are just a few of those practised by lathe specialists.

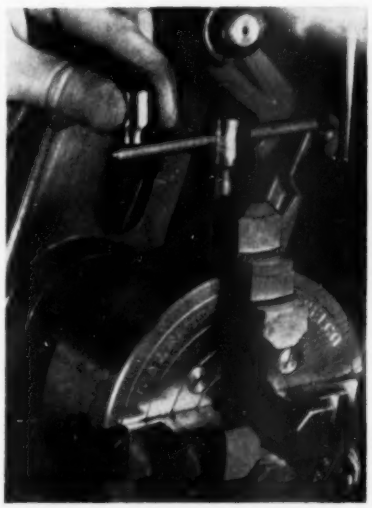


Fig. 4. Crank knob used with this standard chuck key handle makes quicker job of chuck jaw reversing

Fig. 5. Shows how wrench can be used to disengage faceplate which is locked on spindle nose

# More on Fuel Oil Sampling

**This article explains why fuel oil sampling is not as simple as it seems, and describes equipment and precautions needed for good results**

**By PAUL F. SCHMIDT**

Allied Oil Co., Inc.

OIL SAMPLING is simple enough, but to secure a good sample is not so easy. Of all petroleum products, fuel oils are the most difficult to sample, for they are not uniform, and even in a tank filled with one type of oil it is possible to secure many different samples. Most petroleum products are controlled by narrow specifications, but heavy fuel oils have wide ranges, because oil burners, unlike gasoline or diesel engines, do not need an exact fuel.

Finding a good sampling spot is not always easy. Many tanks have large manholes, but they are often inaccessible, or have their covers held down by rusty bolts. The gaging hole is usually too small for a sampler to go through, and often the fill-pipe has too steep an angle to let a sampler go straight down. Sometimes the only way to get a sample is to lower the thin gaging stick and when withdrawing it from the oil, run it between two fingers and catch the drippings.

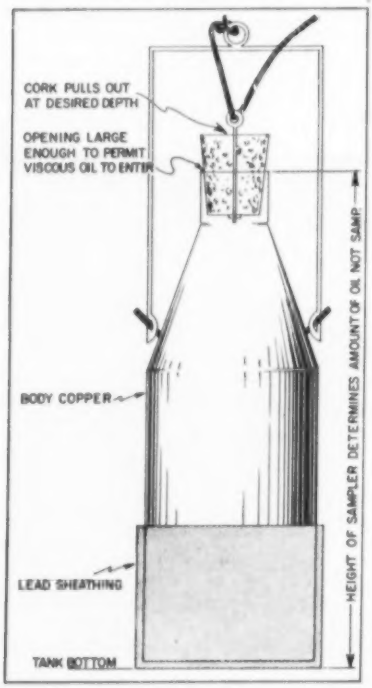

CORK PULLS OUT AT DESIRED DEPTH
OPENING LARGE ENOUGH TO PERMIT VISCOUS OIL TO ENTER
BODY COPPER
LEAD SHEATHING
TANK BOTTOM
HEIGHT OF SAMPLER DETERMINES AMOUNT OF OIL NOT SAMP

Fig. 1. A weighted sampler for heavy fuel oils

Another difficulty is the temperature of the oil. When cold, heavy oils become viscous and thick, making it difficult for them to flow into the sampler, and preventing the sampler sinking through the oil to the bottom of the tank.

Useful information can be obtained from the appearance of a sample. If heavy oil has a dull black color, it may be contaminated by sediment, as clean oil should have a shiny luster. If the oil has a brown cast, it is usually contaminated by water, which can be proved by placing a little oil on a blotter and smoothing it out with the finger; the oil will soak into the blotter while the water remains on top.

### Reasons for Sampling

Samples are taken when combustion trouble occurs, to find out if the fuel is to blame; to check the amount of water and sludge at the bottom of a storage tank, particularly if fuel lines and strainers are clogged; to see if the specified oil has been delivered; to compare one tank of oil with another, and to check the results of blending.

### Types of Sampler

There are two types of sampler in general use; those opening at the top and those opening at the bottom. The first type, shown in Fig. 1, has an opening which is closed by a cork that can be jerked out after the sampler has been lowered into the tank. It is good for taking samples at different levels, but is no good at the bottom of the tank as no sample can be taken below the height of the bottle.

The second type has a trip which closes the container when it hits the bottom of the tank, thus obtaining a sample close to the bottom. This type is shown in Fig. 2. It is also made so that it can be closed at any level in the tank by pulling a trip cord attached to the sampler.

Samplers are from 1½ in. diam and 10 to 15 in. long. Those for distillates are usually made of glass, so that the color, water and sediment can be seen as the sampler is withdrawn from the tank. For heavy oils, brass or copper samplers are used, as they are spark-proof and heavy enough to sink through the oil. Sometimes a sampler is called a thief, and "thieving a sample" means taking a sample.

### Types of Sample

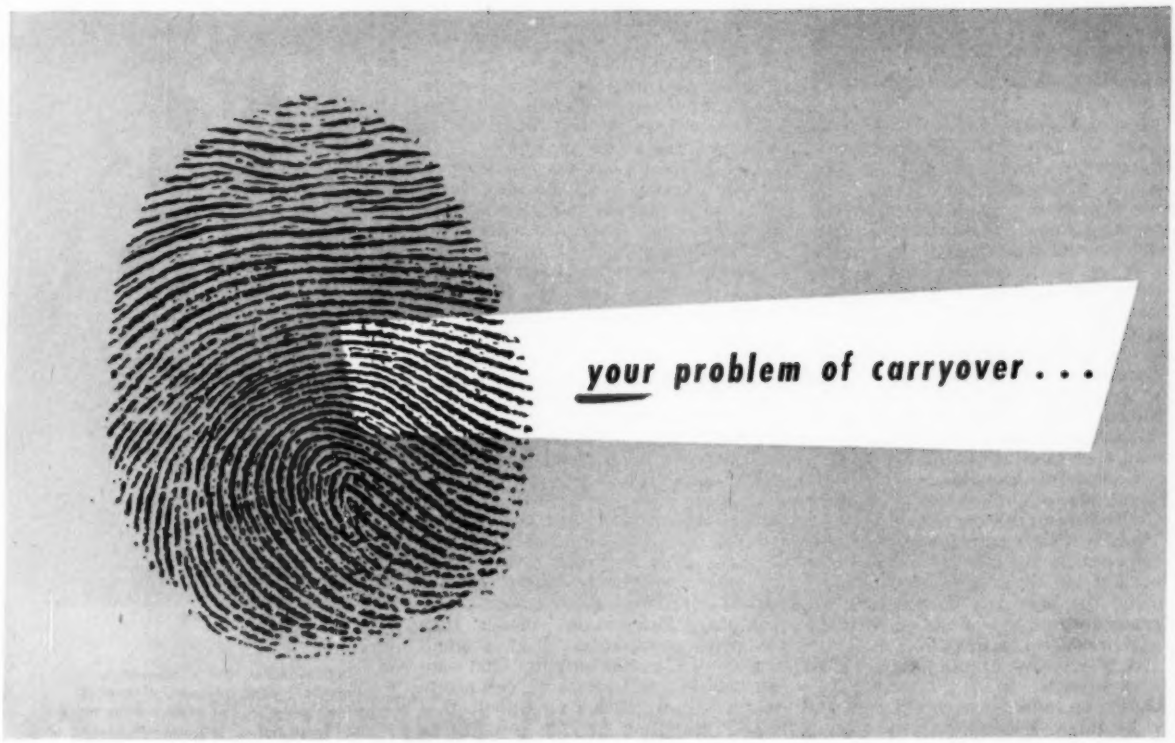
**Bottom Sample:** — A bottom sample is taken directly off the bottom of the tank to determine the amount and type of sludge. Water, being heavier than oil, will nearly always be found on the bottom. With heavy oils it will be in the form of an emulsion and seldom in the clear state; with distillate oils, the water usually shows a definite separation from the oil.

To find the amount of water present without having to take an oil sample, "water detecting paste" is smeared on the gage stick or gaging tape which is lowered to the tank bottom and left there for a few minutes. Where clear water is present the paste will turn red, in contrast to its normal grey. If the water and oil are emulsified, however, the paste will show red spots or speckles. This paste works well with light distillates, as Nos. 1 & 2 kerosenes, gasoline, or No. 4 oils, but not so well with heavy oils, for it becomes coated with the viscous oil as it is lowered into the tank and water cannot penetrate to the paste.

When sampling storage tanks for bottom sludge, it is possible that none will be found even though there is trouble with blocked lines and strainers. What happens is that the oil cleans the spot where it is discharged into the tank and pushes the sludge away. If the sample opening is over this spot the sample will show no sludge even though there is quite a lot in other parts of the tank. Fig. 3 illustrates this situation. Recently a 20,000 gal horizontal tank was sampled from open manholes and no sludge found. When the tank was cleaned out, three drums of sludge were removed. It had been pushed to the ends of the tank, while the part directly below the manhole, where the oil entered, was perfectly clean.

**Samples from Different Levels:** — When light and heavy oils are blended in the same tank, they tend to separate, and samples must be taken at different levels to see if the oils have mixed properly. Each sample should be checked separately, and if they are all found to be the same, they can be mixed to form a composite sample of the oil in the whole tank. When

**Editor's Note: — The author, Paul F. Schmidt, is well known to our readers for his splendid series of articles on fuel oil characteristics, that ran in POWER ENGINEERING during 1950 and 1951. His present article on Oil Sampling deals with most of the aspects of the subject not covered by our articles in the April, July and August '52 issues.**




. . . is as individual as a fingerprint. No two problems are alike and there is no standard solution. However, with a comprehensive engineering approach and application of selected anti-foam agents, even an extremely difficult problem can be overcome.

To illustrate the point, a steel mill boilerhouse operating on 100% make-up water, produced 6,000,000 pounds of steam daily to operate its turboblowers. Continuous carryover of boiler water solids with steam was encountered. Regulators and valves were coated with heavy deposits. Frequent slugs of water passed through the superheaters into the turboblowers. And, the superheater temperature charts literally resembled a picket fence!

Betz Engineers recommended the application of proper anti-foam agents and effected a remarkable improvement. Carryover has been *eliminated*, and superheater temperature has been *increased* approximately 50 degrees.

Why not ask a Betz Engineer today to explain how anti-foam agents can help solve your own particular carryover problem and save you time, money and effort in your plant? Ask him too, about the complete Betz *Specialized* Water Conditioning Service tailor-made to your needs. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

---

*Betz Technical Paper 115 "Carryover Prevention With Anti-Foam Agents" is free for the asking. Write for a copy today.*

**BETZ**

CONSULTANTS ON ALL WATER PROBLEMS

For more data circle 553 on Post Card

blended oils separate, with light oils going to the top and heavy ones to the bottom, the burner may be using oils of different specifications from one minute to the next. Under such circumstances, preheat temperatures and air-fuel ratios will be inaccurate.

When oils from different sources are all pumped into one tank, there may be blending due to pumping agitation, but it is still possible to have several different viscosities. Consistent and efficient combustion is impossible under these circumstances, and several samples must be taken to determine the quantity of each type of oil in the tank.

**Composite Sample:** — This type of sample is taken when an average of the entire tank content is wanted. There is always some foreign material dispersed in the oil, and a composite sample will show how much, besides being the best way to compare the grade and quality of the oil with the purchase specifications.

Any mixture of samples is called a composite. In large tanks they should be taken at several levels, the more taken the more representative the results. With small horizontal tanks, tank cars, and trucks, samples from top, middle and bottom are sufficient.

When taking composite samples the bottom one should be taken above the sludge or water. The purpose of a composite sample is to show the average quality of all the oil in the tank, and the sludge would give a false indication. For example, there may only be a small amount of sludge on the tank bottom, but if three samples are taken, from top, middle and bottom, the composite sample will show one third sludge in the whole tank, which is obviously wrong.

Sometimes a composite sample is taken by lowering the sampler nearly to the bottom of the tank, then jerking out the cork and pulling the sampler slowly to the surface. The oil flows into it as it rises, and by the time it reaches the surface it contains a composite sample of the whole tank. The sampler should reach the surface with space in it for more oil, so there will be no possibility of it filling completely at any one level.

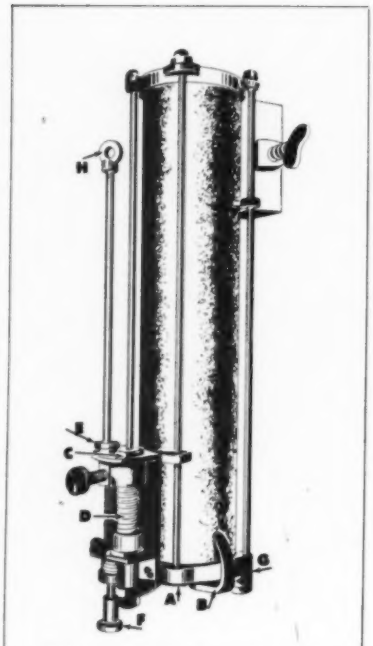
**Line Sample:** — Sometimes it is impossible to take samples from a tank, and they have to be taken from the line instead. They are not very accurate as they do not represent the oil in the whole tank, but they give a good idea of the oil being burned at the time they are taken.

A small valve inserted in the line between tank and burner makes a good outlet for line sampling. Where it is impossible to add a valve, the top of the oil strainer may be removed and a sample obtained by dipping with a small can.

Sometimes a line sample is taken while oil is being pumped out of trucks, tank cars, and boats. "Batch style" means that samples are taken at intervals during pumping and then mixed to give a composite sample. "Drip style" means that oil drips continuously from a small valve while discharging and accumulates to form a composite sample. Both methods are good. It is important that the oil flows for a short time before the sample is taken so that sediment and water at the outlet will be brought out with the first flow of oil and will not form part of the sample.

Line samples are sometimes taken from the drain spigot on the oil pump.

**Screen Samples:** — When trouble occurs, sludge and lint will often be found on the strainers in the fuel lines, blocking the oil flow to the turners. When this happens, the materials should be scraped off and examined to find out what it is and where it comes from. This trouble often happens when there is so much sludge on the bottom of the tank that it gets drawn into the suction lines; it also occurs when a new delivery of oil is pumped in and the agitation of the pumping disperses the sludge throughout the tank. Breakdown and instability of the oil also causes trouble due to the heavy insoluble particles blocking the strainers.




Spring shutter (A) is opened to a cocked position by means of lever (B) and is held in that position when top of hinge bolt (C) engages with trigger piece (E). Tension is maintained by hinge bolt spring (D). Sampler is lowered to bottom of tank until trigger piece foot (F) touches bottom pushing up the trigger piece so as to release the hinge bolt allowing the spring shutter to swing back into bottom ring (G) making a ground seat joint. The spring shutter can also be released at any desired depth in the tank by attaching a chain to eye (H).

**This picture and description through the courtesy of the Transit Mfg. and Sales Co., Parkersburg, W. Va.**

Fig. 2. Krouse Oil Sampler for taking samples off tank bottom. It can also be used at other levels

To get good samples, the containers must be perfectly clean. They are not always so; dirty milk bottles and old paint cans are often used. Also, if the container has been cleaned with a solvent, this fluid must be removed or it will contaminate the sample. Containers should have a substantial cap, and rubber gaskets should not be used, for the oil will deteriorate them.

There should be enough oil in each sample for all the tests that have to be made on it. A quart is enough for most fuel oil tests, while for composites, the individual samples are usually a pint.

Before testing a sample, it should be thoroughly shaken to mix any sediment and water which may have settled to the bottom of the container. If the sample is heavy and viscous, it should first be heated, which will thin it and make mixing easier.

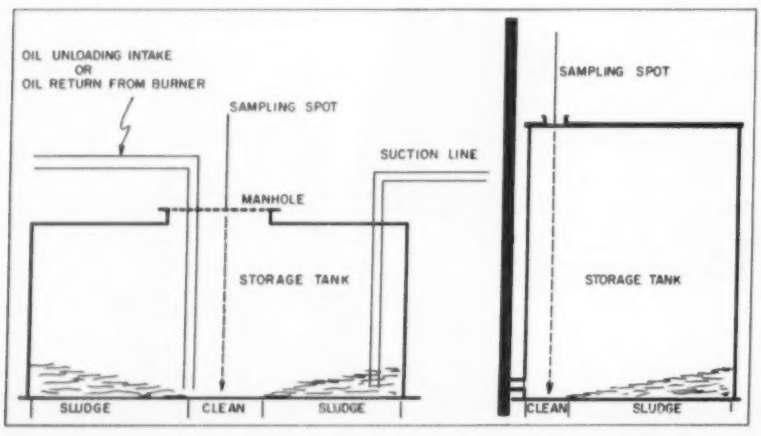
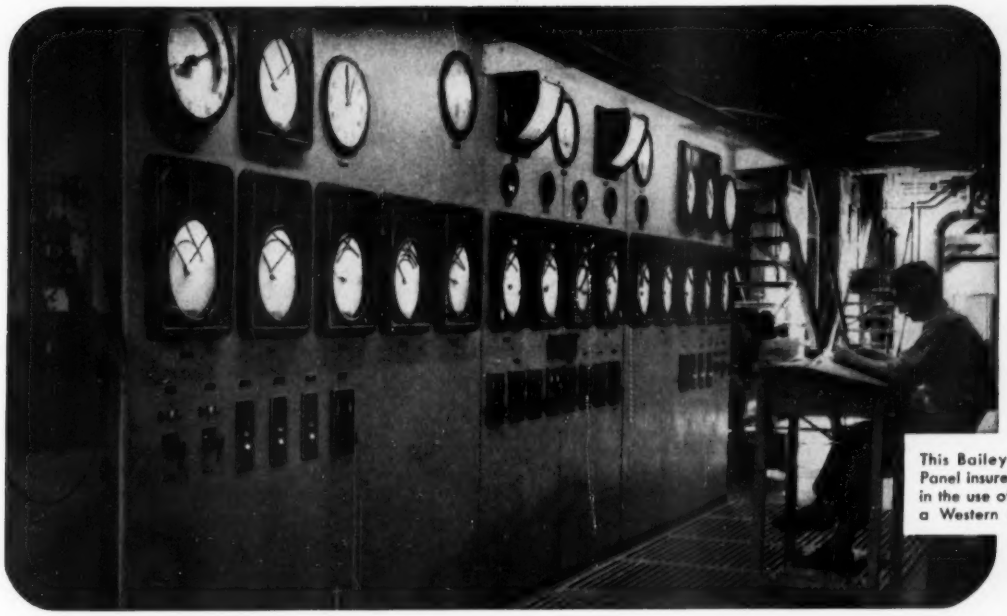



Fig. 3. Shows sludge pushed away from the oil discharge point; a sample taken there will be inaccurate



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

# What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

**BAILEY METER COMPANY**

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

*Controls* for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

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# Power Engineers Abate Air Pollution

UNTIL RECENTLY, the atmosphere was considered a natural means of waste disposal. Almost without exception the furnace gases from homes, schools, small and large industries, alike, discharged their furnace gases with all the products of combustion into the atmosphere. With the increase in population and concentration of industry, this practice cannot be continued without deleterious effects. The installation of fly-ash collectors, and the disposal system for a large existing industrial plant, show the problems involved. They were discussed in detail by Bert S. Norling, power design engineer, E. I. duPont de Nemours & Co., at the last annual meeting of ASME.

A survey was made to determine the plant's contribution to the conditions causing the nuisance. Tests were run to determine the fly-ash emission rates from the power house stacks. At the same time, the downwind concentration of fly ash at ground level was also measured. The fly-ash concentration at ground level was found to be from two to seven times in excess of values normally considered to be acceptable. The decision was then made to proceed with the installation of collectors.

### Selection of Collectors

The question that naturally arises then is, what collection efficiency is required? This is a difficult question. A heavy capital investment will cut deeply into the profitable operation of the plant since power costs must be included in the cost of the manufactured product with no assurance that the product sale price can be increased to cover the additional investment. At present, the collected fly-ash cannot be considered as salable. There will be some return through reduced induced-draft-fan maintenance but this is more than offset by the addition of operating and maintenance of the collector installation. Thus, the installation of fly-ash collectors and the facilities for disposal become a costly burden on the operation of the plant. Nevertheless, abatement is a plant responsibility and good community relationship is the compensating return.

### ASME Code Was Guide

There were no local ordinances establishing the required collection efficiencies or limiting emission rates. Lacking any such mandatory regulation, the model ordinance suggested by the ASME was used as a guide, for it is generally accepted and is one of the more stringent ordinances. The ASME Code requires that the dust loading of stack gases shall not exceed 0.25 grains per cubic foot with the exception that a collector efficiency of not more than 85 per cent is required for new plant installations and not more than 75 per cent for plants constructed prior to the effective date of the ordinance. The ordinance in the nearest city is far more lenient than the ASME Code. The atmospheric dust loading at ground level downwind from the stack, was expected to be reduced to less than 0.55 grains per 1,000 cu ft as this figure is considered as acceptable in a normal city. Collectors with an average efficiency of 85 per cent or better would then be expected to give the required clean-up. On this basis, the mechanical collectors were accepted.

After completion of installation of collectors at this plant, a local civic organization voluntarily wrote a letter to the company expressing their appreciation and specifically stated that there was no longer a dust nuisance in the community.

Efficiency of the mechanical collector drops off rapidly as the particle size decreases below ten microns — one 25 hundredth of an inch (1/2500 in.).

If collectors are installed when the plant is built, the cost is but a fraction of the cost to install them later, particularly when no provisions are made for the future installation.

The mechanical collector has in general been a lower cost installation than the electrostatic precipitator and it has been used more widely in the industrial plants. It does not give the clean-up that is possible with the electrostatic precipitator. If the electrical characteristics of the ash are not suitable, the precipitator may also give a performance far below that expected. There seems to be a field for each type. At present, a combination of the two types appears to overcome many of the limitations. However, cost and space prohibit the use of the combination on most existing boiler plants. The higher efficiency mechanical collectors limit the fly-ash emission rate sufficiently to meet nearly all of the existing ordinances except the APCA ordinance applied to large plants.

It is to be expected that future ordinances will become more restrictive and the improvement in the application of collectors or any other means of reducing atmospheric contamination must be given careful study for considering future installations.

"Okay—out with it! Which one of you dizzy birds tried to stop this leak with his bubble gum?!!"

# CONO CONTROL VALVES . . . for water treatment

**SPECIFIED BY THESE FIRMS**
(partial list)

American Cyanamid—Ion Exchange Div.
Belco Industrial Equipment Div., Inc.
Cochrane Corporation
General Filters, Inc.
Graver Water Conditioning Co.
Illinois Water Treatment Co.
Permutit Co.
Worthington Pump & Machinery Corp.

**INSTALLED IN THESE PLANTS**
(partial list)

| | |
|---|---|
| Atomic Energy Commission | Arco, Idaho |
| J. T. Baker Chemical Co. | Phillipsburg, N. J. |
| Blockson Chemical Co. | Joliet, Illinois |
| Consolidated Edison Corp. | New York |
| Dow Chemical Co. | Freeport, Texas |
| Dow Chemical Co. | Velasco, Texas |
| Dow Chemical Co. | Pittsburg, Calif. |
| Gulf States Utilities | Baton Rouge, La. |
| Johns-Manville | Manville, N. J. |
| Penna. Power & Light | Shawmont, Pa. |
| Philadelphia Electric Co. | Schuylkill Station |

Cono Close Coupled Pneumatic Control Valves provide unbroken service day in, day out—year in, year out—in the automatic operation of demineralizers and other process systems. Hundreds of Conoflow valves, like those shown here, have been in operation many years without maintenance or repair. Cono Control Valves are available in assemblies for on-off service (guaranteed bubble-tight shut off) or for throttling control. Available with optional features such as handwheel type limit stops as shown, plastic position indicators, and micro-switch attachments for actuating remote visible or audible signals. Body sizes up to 12" in all materials—rubber lined, Saran lined, alloys, etc.

*Write or phone for Conoflow's usual personalized attention.*

Cono Controls

CC-900

# CONOFLOW CORPORATION

*Foremost Manufacturers of Final Control Elements*

**2100 ARCH STREET, PHILADELPHIA 3, PENNSYLVANIA**

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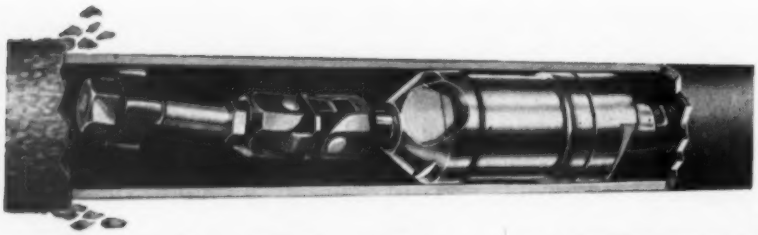


# ROTOJET®

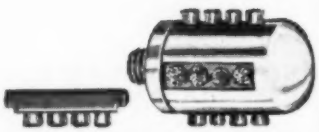
## Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸ INSIDE and OUTSIDE

**You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.**

**Try the new Rotojet, and no other tube cleaner will ever satisfy you.**

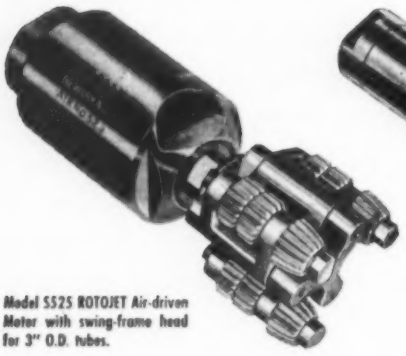
### Economical Roto Brushes

**Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.**



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model 5525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model 5505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

**ELLIOTT COMPANY-ROTO DIVISION**

147 Sussex Avenue Newark 1, N. J.

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## Petroleum Pitch

(*Continued from page 75*)

scale, and is easier than shutting off the burner and withdrawing the cups.

The whole system can run on Bunker "C" oil without altering any equipment. The storage tanks can be filled with oil, and the pumps will handle it without difficulty; the steam jacketing would not need to be used nor the oil fired pre-heater.

### Dangers in Handling Hot Pitch

There are two dangers in handling hot pitch. Like fuel oil, it must not get too hot, and it must not come into contact with water, which instantly turns to steam and causes the pitch to bubble out of the tank.

If the pitch flow round the oil fired pre-heater were to stop, the pre-heater tubes would get too hot, so an electric alarm sounds if the pitch in the pre-heater reaches 375 F.

### Fuel Oil Treatment for Pitch

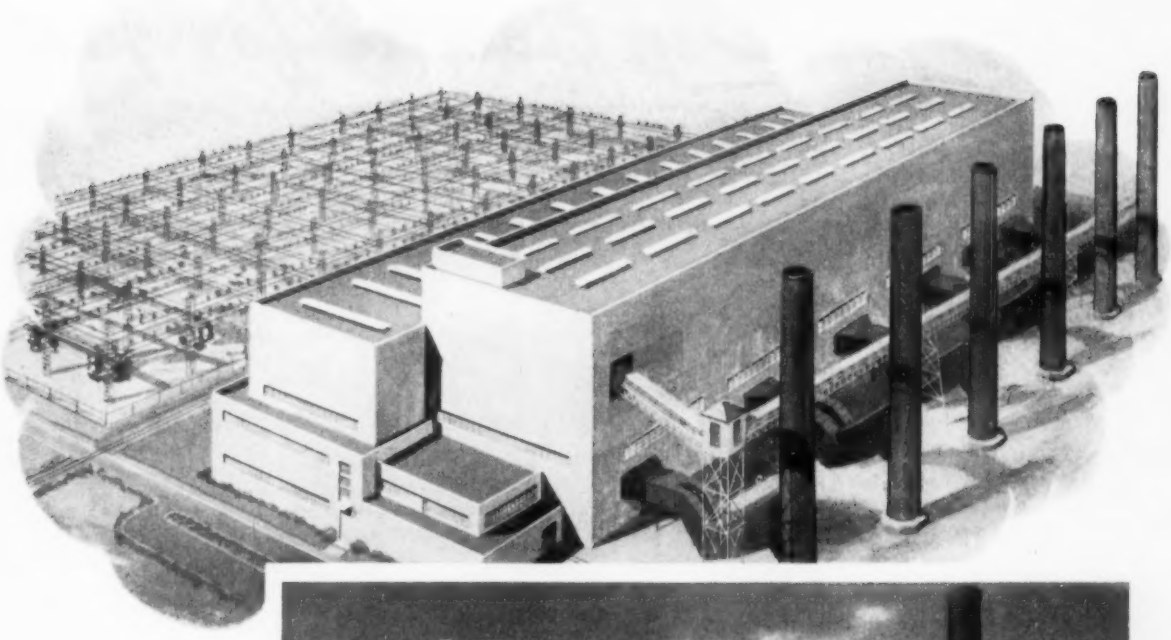
The compounds on the market which improve the flowing and burning properties of heavy fuel oils also improves the behaviour of pitch. We have used several brands of treatment in the past for sludge control and for keeping tube surfaces clean, but on the whole with very little benefit to us. Since November 1951, we have been using a compound known as KOR for both purposes, and noticed an immediate improvement in operation. The deposits on tubes were fluffy and readily removed by the soot blowers. Exit flue gas temperatures dropped about 20 deg and the stacks were cleaner. Sludge is not building up in storage tanks and old accumulations have been dissolved and burned. Strainers and burners have required only minimum attention.

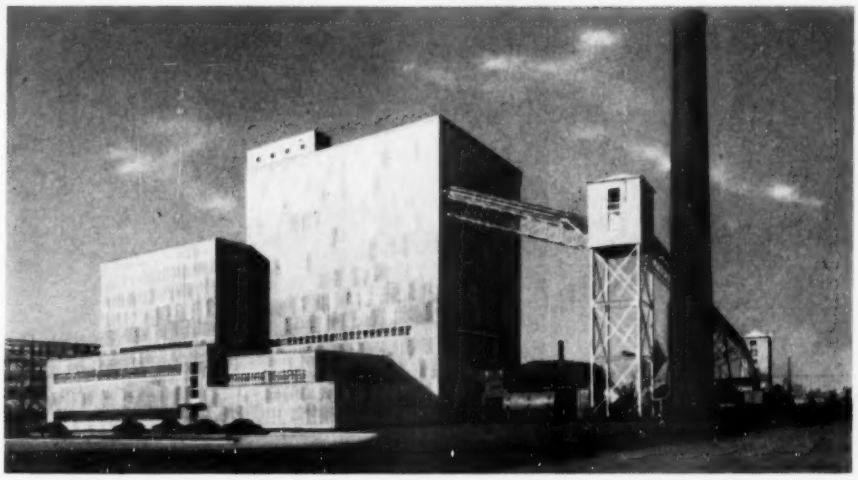
The compound comes as a thin liquid which has to be added in the proportion of one quart to a thousand gallons of pitch. If it were poured straight into the storage tank it would cause dangerous steam bubbles, so it is introduced into the system on the suction side of the circulating pump, as shown in Fig. 5. By opening main valve A slightly, enough suction is produced at the control valve to enable the liquid to be drawn into the system without difficulty.


### Microfilm Edition

The microfilm edition of POWER ENGINEERING, Volume 56, 1953, January to December issues inclusive is now ready. It costs $4.75 and should be ordered direct from University Microfilms, Inc., 313 North First Street, Ann Arbor, Michigan. DO NOT order it from us.

Please note that these microfilm volumes can be obtained only by firms, libraries, and individuals on our controlled and subscription lists.





*Portsmouth Power Station is designed for an ultimate total of six units, each of 100,000 kilowatt nameplate capacity*

# More Kilowatts for a Growing Region

The system-wide generating capacity of Virginia Electric and Power Company was increased to nearly 1,000,000 kilowatts early in 1953 and in 1954 it will be further augmented by an additional unit of the Portsmouth Power Station near Portsmouth, Virginia.

The initial unit of this new station, a 100,000 kw preferred standard machine, is already "on the line".

Stone & Webster Engineering Corporation was retained for the design and construction of the new facilities.

**STONE & WEBSTER ENGINEERING CORPORATION**

**A SUBSIDIARY *of* STONE & WEBSTER, INC.**

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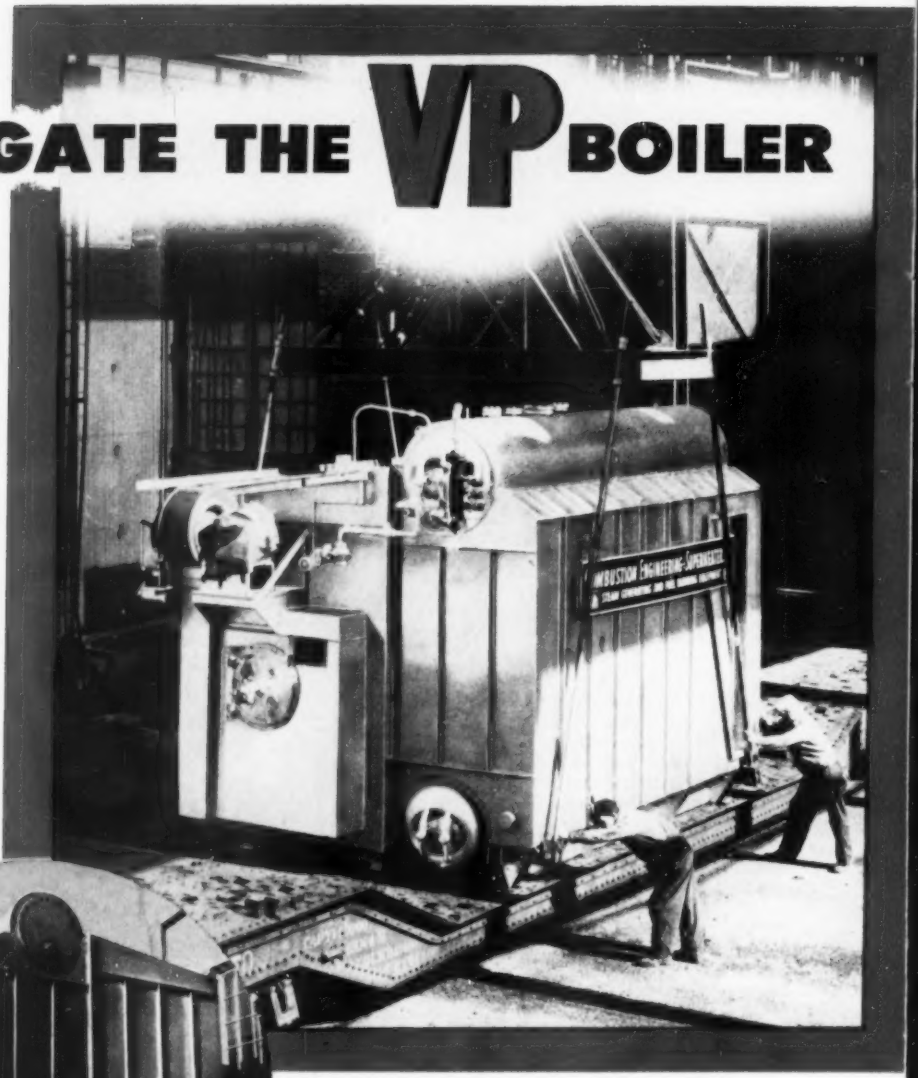
# *Don't settle for just*

# INVESTIGATE THE VP BOILER



***VP Boilers are available in capacities from 4,000 to 30,000 lb of steam per hr; pressures to 250 psi. Send for Bulletin VP-112.***

## COMBUSTION

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

# A Package Boiler

## ...the Package Boiler with EXTRA features

**If you're in the market for a Package Boiler, here's the problem you face. There are a number of water-tube, package boilers being offered today. Most of them look pretty much alike. And, in some respects, they *are* alike.**

**But you're looking for the "best buy" in a package boiler. Therefore your interest lies in points of difference rather than points of similarity. The C-E Package Boiler, Type VP, offers all the better design features of its contemporaries *plus* the following extra features:**

1. **Fully Water Cooled Furnace** — More cooling area per cubic foot of furnace volume than any other boiler of the VP's size and type. In all but the three smallest sizes, the VP Boiler has water-cooled walls on *all six sides* of the furnace — including the burner wall.

2. **Larger Lower Drum** — The 30-in. diameter lower drum permits a simple, symmetrical tube arrangement . . . provides easy access for washing down or inspection . . . its greater water storage capacity facilitates the handling of fluctuating loads.

3. **Centrifugal Fan** — This more efficient type of fan operates at lower speed than other types and is quiet in operation. In fact, its average noise level is less than half that of typical high-speed fans used on most package boilers.

4. **Simple Baffle Arrangement** — Minimum changes in direction of gas flow — no baffle at all in convection bank of larger VP Boilers. This means lower draft loss . . . simplified soot blowing . . . absence of dead pockets, thus, maximum heat pick-up. In the intermediate sizes, a water-cooled baffle assures minimum maintenance.

B-673

**ENGINEERING Inc.**

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

C-E

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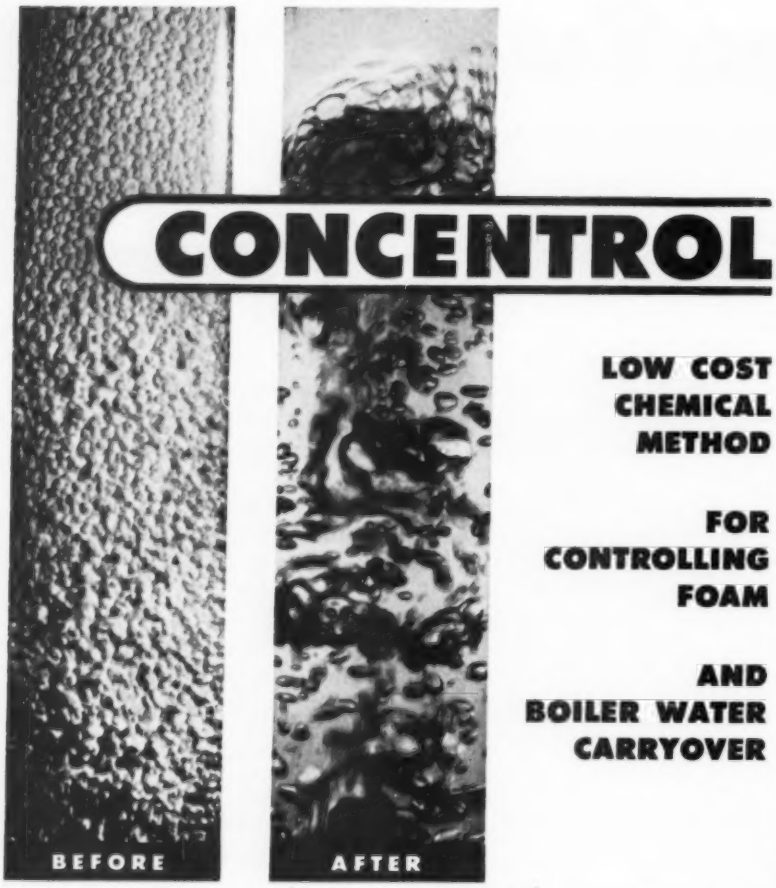


# CONCENTROL

**LOW COST CHEMICAL METHOD**

**FOR CONTROLLING FOAM**

**AND BOILER WATER CARRYOVER**

Laboratory demonstration shows foaming of highly alkaline solution in glass test cylinder.

Same solution after addition of 12 ppm of Bird-Archer Concentrol antifoam.

**LABORATORY PROOF**

● Tests and plant operating records in all parts of the country have established the effectiveness and economy of Concentrol chemical treatment to combat wet steam problems. Where boiler water carryover is caused by foaming due to high alkalinity and high proportion of dissolved solids in the water, Concentrol is essentially a surface active agent that causes breakdown of bubble film, preventing foam formation.

Concentrol is supplied in liquid, powder or briquette form—can be fed either continuously or in slugs to boilers. Formulations of Concentrol can include organic sludge conditioning agents and other water treatment chemicals for boiler treatment as well as antifoam. Concentrol eliminates the need for costly pre-treatment of water and high blow-down rate. It is fast acting and resistant to hydrolysis or breakdown under normal boiler temperatures and pressures.

A Bird-Archer 8 Point Service Engineer is as near as your phone. For friendly counsel call him or write directly to Bird-Archer outlining the details of your boiler operations.

*Engineering plus Chemistry equal Bird-Archer Service*

**BIRD-ARCHER WATER TREATMENT**

**THE BIRD-ARCHER COMPANY, 4337 NORTH AMERICAN ST., PHILADELPHIA 40, PA.**

**NEW YORK • CHICAGO**

**IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario**

**IN MEXICO: Calderas y Accesorios, S. A., Amsterdam 291, Mexico, D. F.**

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## Clean Control Air

*(Continued from page 85)*

system is very bad, it is advisable to have a separate small filter for each instrument in addition to the one already described.

### Operation Below Freezing

If any part of the control system is liable to freeze, the lines can be kept warm by steam or electric tracing, and the air can be reheated before entering the instrument. But where the lines are long or there are several instruments, it will often be cheaper to remove more moisture from the air by passing it through a condenser and filter after it leaves the receiver. There are several combined condensers and filters on the market which are really small versions of the aftercooler and filter described above. The air is passed over a group of cooling coils, which condenses most of its remaining moisture and oil, and then through filters of flannel or fine cloth which remove practically all dirt and oil. Two are usually needed for continuous operation, so that one filter can be working while the other is being cleaned and replaced.

For some applications, even this extra condensing is not enough, particularly if the instruments have to operate around −20 to −30 F. For operation at such low temperatures, all traces of moisture have to be removed, and this is done by passing the air through chemical dehydrators as described below.

### Absorbers and Adsorbers

The terms "absorber" and "adsorber" are often used rather loosely and this is a good opportunity to explain the difference. Some materials, such as sulphuric acid or ammonia, have a great attraction for water and will react with it chemically. These chemicals extract moisture from the air, but they are seldom used for this purpose because they are highly dangerous or have unpleasant smells, and they cannot easily be dehydrated and used again. These substances with which water reacts chemically are called "absorbers."

An "adsorber," on the other hand, takes out water and holds it on its surface, but does not combine with it chemically. Blotting paper, for example, is an adsorber, and so are sugar and salt. The adsorbed moisture can be driven out of the material by heating, leaving it as good an adsorber as before. Several chemicals have this property of adsorbing moisture from the air, and they are used commercially for drying air. Examples are silica gel, activated aluminum, calcium chloride, lithium chloride, etc. When air has been drawn over or through these chemicals, it is dry enough to be used at temperatures as low as −100 F.

DARLING VALVES

## INSIDE STORY...

**on trouble-free valve performance**

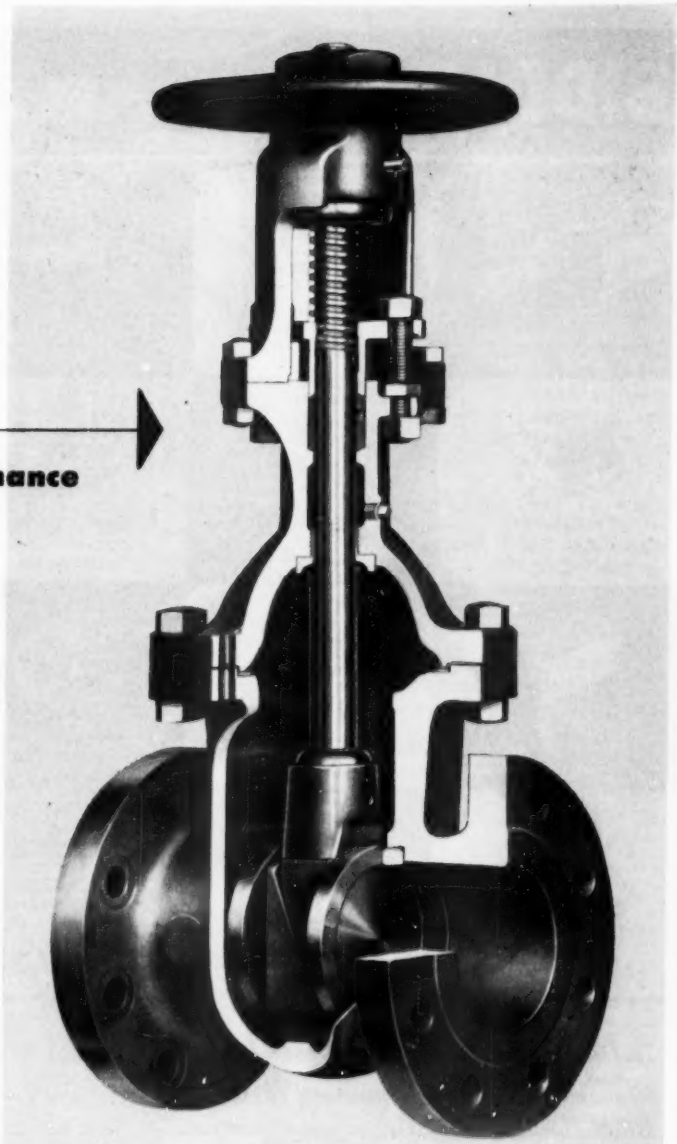
# Install DARLING Revolving Disc GATE VALVES

Just what the doctor ordered . . . that's what users say about Darling fully revolving double disc, parallel seat gate valves. *Reason:* These unique valves adjust automatically to compensate for valve body distortion.

Moreover, Darling gate discs, independently hung from the upper wedge and free to revolve completely, change their seating position at each closing. This means uniform wear distribution. Valves work better and last longer, require less attention, less maintenance.

### Wide Range Of Sizes And Types

If you're not already a Darling revolving disc gate valve user, let us prescribe the valve you need to cure *your* valve trouble. Darling gate valves come in a wide range of types and sizes . . . and for pressures up to 1500 pounds. Simply outline your particular service needs or ask for a complete descriptive bulletin.




**Above, left: Disc and seats are parallel. No problem. Right: Seats out of parallel because of unequal expansion or contraction but discs adjust themselves to give positive closure. *Still* no problem! Radiused face of wedge allows discs to adjust tightly against both seats.**

**DARLING VALVE & MANUFACTURING CO.**

**Williamsport 19, Pa.**

*Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario*

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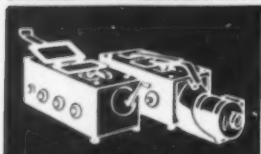
# BIDDLE *Instrument News*



MEGGER INSULATION RESISTANCE TESTERS

FRAHM RESONANT REED FREQUENCY METERS & TACHOMETERS

"TTR" TRANSFORMER TURN RATIO TEST SET

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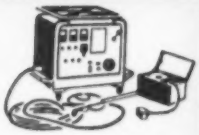

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## Separate Oil from Steam

(*Continued from page 91*)

lattice which can be removed easily for cleaning and is designed to subject the steam to a violent buffeting action. An example of this type, which was very common in Europe, is the "North Eastern Interceptor" which has seen some use in the British marine service.

### Centrifugal Force Separators

The earliest designs utilized a spiral vane to impart the swirl, as in the "Keystone" separator shown. Among modern designs, the "Supreme Vortex", manufactured by Messrs. J. H. Carruthers of Glasgow, Scotland, is worthy of special attention. The "Supreme Vortex" is widely used in Britain, the British Commonwealth, and to some extent in the U.S.A. The manufacturers claim that the extraction of impurities at all rates of flow is over 99 per cent of any liquid or solid particles down to 1/250 inch diam, also a high percentage of even finer particles. Re-entrainment of extracted matter is impossible no matter how high the velocity. The pressure-drop is negligible and the separator is self-clearing even when the proportion of solids is as high as 20 per cent. It may be fitted to either vertical or horizontal lines, is relatively small for a given capacity, and is available for any size of pipe.

A separator of long standing and widely used in America today is that designed by the Swartwout Company. A number of "Swartwout" separators are produced for various applications and ranges of operation. They are small, the efficiency of separation is high, and back-pressure is negligible.

The Centrifix Company has produced a new type of centrifugal steam separator for small diam exhaust lines, and a similar one for larger pipe sizes. A separation of 99 per cent is claimed for them.

### Adsorption and Filtration

Oil can be removed very effectively by adsorption and filtration. Disadvantages are high back-pressure for the engine and the difficulty and inconvenience of cleaning the filter. These, not to mention the great improvements in other methods of steam separation, have made steam filters obsolete. Pure filtration of exhaust steam has been attempted, and one of the best-known devices was the Edmiston Cheese-Cloth Filter.

In the adsorption type, a large chamber was filled with coke, brick, broken tile, or other adsorbent materials (hay and straw were much used) and placed in series with the steam pipe. The idea was crude, the apparatus large, and it had to be frequently replenished. (See ASME Transactions 1903, p. 341). There were designs, of course, which avoided some of these defects, and the Loew Grease-Extractor was one of them.

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✔ **PAPER PRODUCTS** "Approx. 30 traps on wax applicators have been replaced with Super-Silvertop inverted bucket steam traps with net savings in steam of 4,000 lbs. for hour." Augusta, Ga.

✔ **FOOD** "Since trapping our kettles with Super-Silvertop Steam Traps we've had a steam savings, had no trouble with the traps, nor have we purchased repair parts." Pittsburgh, Pa.

✔ **HOSPITAL** "We use your trap altogether. We have 100 to 150 Anderson Traps in use, which we find very satisfactory and reliable." Muskogee, Okla.

✔ **DRY CLEANING** "These traps really work and do an excellent job with no care whatever." North Tonawanda, N. Y.

✔ **LAUNDRY** "The 100 Super-Silvertop Traps installed on our presses, tumblers, ironers, etc. work perfectly and are all you claim. The majority have been on line for 5 years and the saving in fuel alone has paid for them." Richmond, Va.

● **Steam Trap users in every industry compliment Super-Silvertops for their long-life, condensate-draining and air-venting ability. A masterpiece in steam trap construction, valve and seat are of a special chrome nickel alloy, developed especially for the corrosion and abrasion conditions in steam lines. The trap can be installed straight-in-line or as an elbow and can be opened for inspection without removing from the pipeline.**

**FREE 36-page book, "Solving Steam Trap Problems" gives the complete story on Super-Silvertops and selecting traps for any equipment.**

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# Super-Silvertop . . . THE ENGINEERED STEAM TRAP

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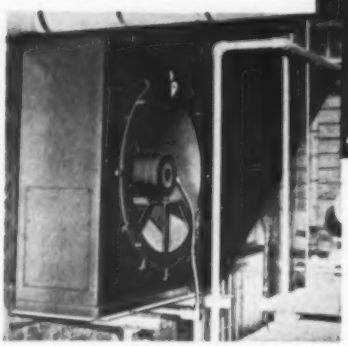
FOR POWER PLANTS



Motor (or Turbine) and Fan in one complete removable unit

In this new high-pressure "Package" Draft Inducer, the motor (or turbine) and fan unit, completely independent of the casing, makes installation considerably easier, and being easily removed, facilitates inspection and maintenance.

ADVANTAGES

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3. Eliminates field line-up problems
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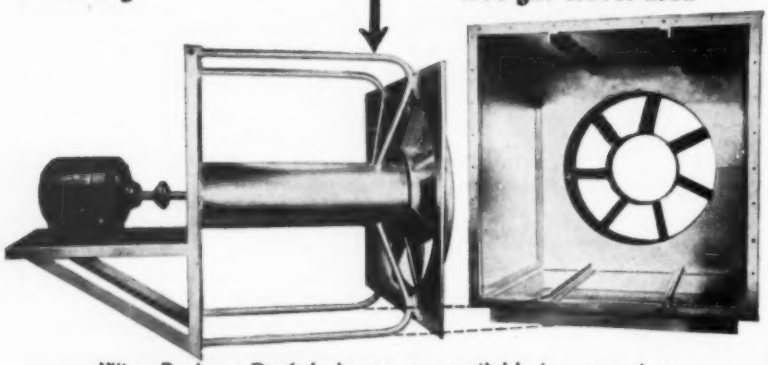

Wing Package Draft Inducers are available in many sizes with either turbine or electric motor drive. For further information write

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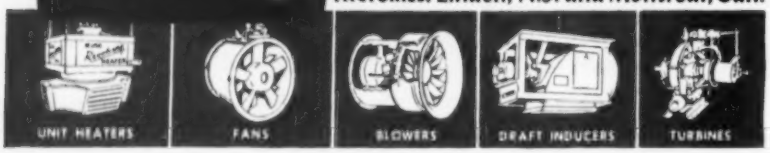


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## Pressurized Firing

(*Continued from page 93*)

Present indications are that by providing for support of the blowing tube in the seal itself rather than with a separately-mounted external bearing excessive relative movement between tube and seal has been eliminated.

### Tentative Conclusions

1 — Pressure operation of large pulverized-coal-fired boilers is now entirely practical, provided short-duration shut downs for correction of minor leaks and other difficulties can be tolerated during the first few months of operation.

2 — Air-pressure testing of the entire setting prior to initial start-up is essential to prevent serious gas and fly-ash leakage which will necessitate frequent pressure-suction transfers; or, without induced-draft equipment, outages for corrective sealing.

3 — On outdoor boilers the gas and fly-ash leakage problem, likely to be troublesome during early operation of indoor boilers, should become almost insignificant. While apparently a definite advantage for outdoor pressure units, it might conceivably result in "hot" furnace leaks being ignored until serious damage to casing or insulation occurred, and thus lead to unscheduled outages. However, this could and should be avoided by vigilance of personnel.

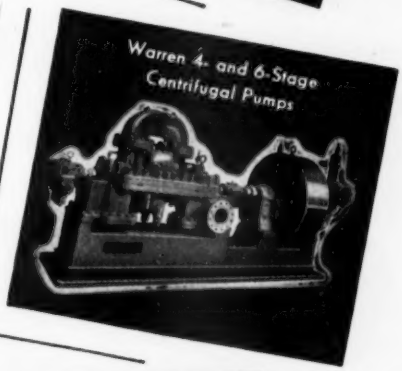
4 — Only significant difficulties now remaining involve pulverizer maintenance, raw coal feeder cleaning, slag blower sealing and bunker fire protection. Practical solutions for the first three are in process and should be realized soon. A completely satisfactory method of protecting against bunker fires seems to be somewhat more distant, although the problem appears to be serious only in the case of those particularly high-volatile coals unusually susceptible to spontaneous combustion.

5 — As soon as the remaining difficulties are overcome and other recent developments prove to be sound over a reasonable length of time, omission of induced-draft fans will probably be warranted on boilers not subject to heavy slagging or ash removal difficulties.

6 — When heavy slagging or ash removal difficulties are anticipated because of use of unusually low-fusion coals or for any other reasons, boilers should be equipped with standby induced-draft equipment to decrease unscheduled outages and increase unit availability.

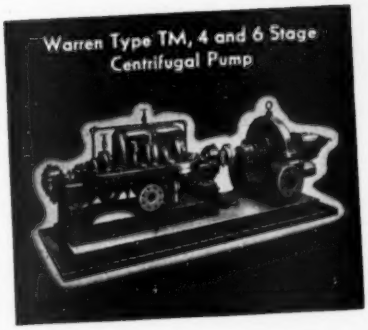
7 — On large reheat units, a unit heat rate improvement of 30 to 60 Btu per net kwh should be realizable from draft-fan power reduction and heat-loss recovery through pressure operation. Further improvement of 50 to 100 Btu per net kwh should also be obtained by use of pressure-tight casing with its controlled sealing-air intake.

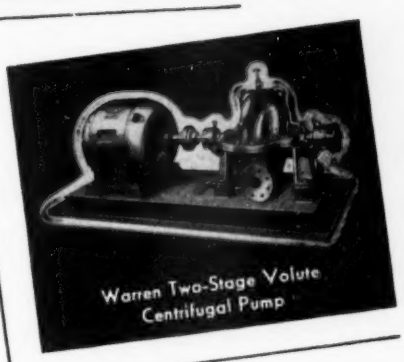
# a boiler plant is no more dependable than its Feed pumps....




For well over half a century Warren has specialized in this field and has kept pace with boiler feed requirements as they have developed over the years.

As builders of both Centrifugal and Reciprocating types and for light, medium and higher pressure services, there is a thoroughly dependable Warren Pump to meet a very large part of all boiler feed conditions.
Their on-the-job record has long been one of reliable, low cost operation.




P-28

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**for pressure—**
**for density—or for position**

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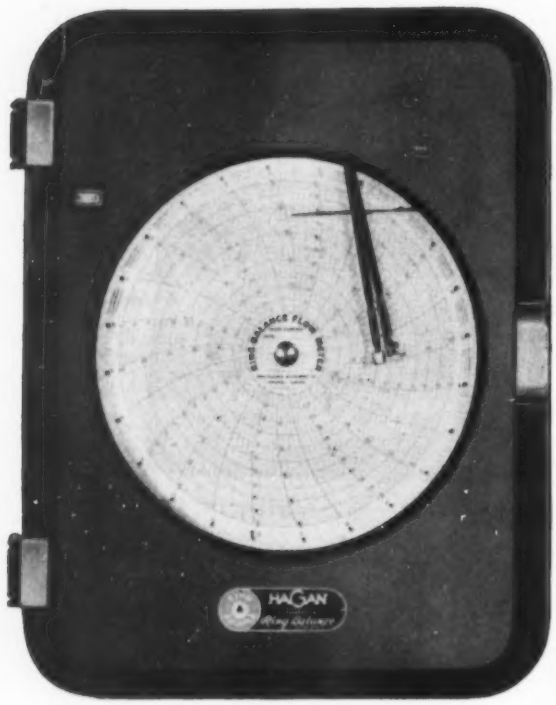


The Hagan Compensated Ring Balance Meter automatically adjusts pressure differential or flow readings to correct for variations in temperature, pressure, density or mechanical positioning.

For flow measurements, the built-in integrator totalizes the corrected flow automatically.

Any measurements, such as drum level, steam flow, or any of the variants such as temperature, pressure, or density may be indicated or recorded on the same chart with the corrected record.

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## Feedwater Equipment

*(Continued from page 95)*

Cure: Modify the vents. On longitudinal flow designs this sometimes requires sequence venting through baffles.

Trouble: — Etching and threatened cracking of tubes in a high level zone — possibly ammonia gas.

Cause: — Poor distribution of steam.

Cure: — Modify steam distribution. (Area B)

Trouble: — Local erosion areas near steam inlet.

Cause: — Excessive steam velocities, (C).

Cure: — Change steam baffling or add deflectors for better distribution. Also applies to drainage from higher pressure units.

Tube vibration may be reduced by improved distribution of steam. In some straight tube designs a few tubes may be removed for laning to give inlet steam direct access to more tube surface. (Fig. 2) In severe cases it may be advisable to devise extra supports.

In longitudinal flow designs, high velocity trouble may sometimes call for by-passing part of the incoming steam to the second loop.

### Metals

As well as the above modifications it is often advisable to use tubes of different material in the zones where failures are most persistant.

Though stainless steel is very resistant to corrosion and erosion it should be used only in tube sheets of the same material and never in soft tube sheets.

Another point is of course heat transfer coefficient. These coefficients vary widely for the various usable metals, but actually have little effect on the over-all operation of equipment due to greater resistances represented by surface films and scale.

While drains would seem to be too self-sufficient to affect the performance of closed heat exchangers, heaters, vent condensers, etc., it is actually possible to have trouble with what may seem to be very conventional arrangements.

Theoretically very little non-condensable gas remains after normal deaeration but since there is always a residue in practice, plus whatever $CO_2$ etc., evolves from chemical reactions in the boiler, all closed steam condensing devices must be vented.

These vents need to be sized for quick blowing out at starting. They should be valved and equipped with a small operating vent valve or orifices suitably sized, probably not over ½ in. pipe size, by-passing the shut-off valve. Sizes depend on the quantities involved and pressure differences.

Drain pots or traps must be vented back to the same pressure as that at the drain. This is essential. The ideal is probably a self venting sump of

*(Continued on page 130)*


# there *IS* a difference *

* **Anti-Stress Deck . . .** another 25 year built-in Preferred "Quality Feature" that means a lower yearly amortized investment.

## PREFERRED *has NEVER lost a pressure vessel tube sheet!*

Again PREFERRED UNIT STEAM GENERATORS come through with another "quality feature" built-in to insure 25 years of dependable low-maintenance service at a minimum efficiency of 80%.

The anti-stress deck construction is an added design feature exclusive with Preferred generators. The rear upper section of the shell is cut away to expose the portion of the tube sheet above the water line. The refractory baffling is installed in such a way that the heat in the refractories is directed to the lower portion where the heat is quickly absorbed by the water. As a direct result of this "quality feature" the sections of the rear tube sheet — above and below the water line — remain in close balance. It is this balance that prevents unequal stress action within the sheet area. It is a recognized safety factor that is insurance for long life and low maintenance.

*That's why we say* . . . records prove there has never been a loss of a pressure vessel tube sheet on Preferred Unit Steam Generators.

*For specific details on this Preferred "quality feature" write today for Bulletin 2000.*

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**If you have any kind of a suspension-recovery problem—whether dust, fly ash, fume, fog or mists—it will pay you to bring it to the leading organization in the field . . . WESTERN PRECIPITATION CORPORATION. Western Precipitation not only pioneered, over 44 years ago, the first commercial application of the now-famous COTTRELL Electrical Precipitators, but also has been a leader for many years in the *mechanical* recovery field with its widely-accepted MULTICLONE Collectors.**

***Result:***

**Western Precipitation is unsurpassed in the all-important factor of "know-how" in BOTH the electrical and mechanical fields . . . knows from years of first-hand experience whether your particular problem can best be solved by mechanical or electrical methods—*or by a combination of the two* . . . can give you a direct and unbiased recommendation on the matter . . . and then can provide the complete installation under *one* responsibility, *one* overall performance guarantee, even where Combination Multiclone-Precipitator (CMP) installations are made!**

***Western Precipitation products and services include . . .***

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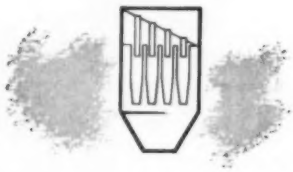
***Electrical Precipitators***

. . . the most efficient recovery equipment for high recovery, long life, low maintenance on practically any type of suspensions, wet or dry. COTTRELLS can be designed to handle a few c.f.m. —or millions—with equal ease, and at virtually any operating temperature. Recovery efficiencies closely approach 100% recovery, if desired, with very low draft loss, minimum power costs and negligible labor costs. *By all standards, Western Precipitation* COTTRELLS *give highest recovery at lowest cost per-year-of-service!*



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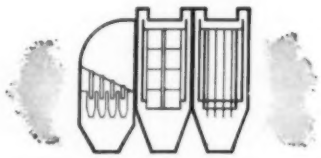
. . . the most efficient, most compact, most trouble-free mechanical equipment for recovering suspensions from gases. Because of their unique small-tube design, MULTICLONES are unsurpassed in mechanical recovery efficiencies—require less space, less maintenance, and are far simpler to install. No filters or screens to replace, nothing to burn or cause fire hazards, no high speed moving parts to repair or replace. These and many other advantages make MULTICLONE Collectors the logical choice on installations where mechanical recovery is selected.



### CMP UNITS
***(Combination Multiclone-Precipitator)***

. . . combine, in *one* compact installation, *both* mechanical and electrical recovery principles so that maximum benefit is obtained from the advantages inherent in each method. The MULTICLONE section centrifugally removes the larger and heavier suspensions (down to a few microns in diameter) . . . and the COTTRELL section then electrically removes the very small particles remaining in the gases. Thus, the bulk of the recovery is obtained with relatively low-cost equipment, and the final clean-up is obtained with equipment having unusually high recovery efficiency—approaching theoretically perfect, if desired.

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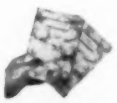
***Send for descriptive literature!***



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## HELPFUL BULLETINS

(*Continued from page 36*)

**128 Oilless Bearings for Conveyors** — Technical Catalog 210, 20 pp, gives data on specifying, installing and use of bearings for screw and roller conveyors, together with operating characteristics. Also includes tables and dimensional drawings. Arguto Oilless Bearing Co.

**129 Vertical Agitator Drives** — Bulletin 5308, 12 pp, covers a line of vertical agitator drive units for application on any type of food or chemical processing agitator tank. In these units the driving motor is an integral part of the design, offering space-saving advantages. Western Gear Works.

## HEATERS, HEATING

**130 Electric Heaters** — Bulletin E-1, 8 pp, describes electric unit heaters and heater sections for general industrial heating as well as for specialized use in heating corners of factories, warehouses. Illustrates overhead downward discharge heaters with revolving and stationary discharge outlets and a heater with horizontal discharge. L. J. Wing Mfg. Co.

**131 Heating, Ventilating Equipment** — This company's "Spring & Summer 1953 Estimating Catalog" is a 36-pp pricing guide covering equipment and supplies in the heating, ventilation, refrigeration and air conditioning field. M. Blazer & Son.

## LUBRICANTS

**132 Analysis of a Lubricant** — Titled, "Properties and Uses of Pure Molybdenum Disulfide as a Lubricant," this paper is described as one of the most complete technical discourses on the lubricating qualities of this compound. Covers its chemical stability, electrical properties, purity, anti-corrosion properties, thermal stability, coefficient of friction and methods of application. The Alpha Corp.

**133 Six Can Do It** — For the power engineer who finds himself with too few oilers and too many lubricants, this 12-pp booklet offers some timely suggestions. Sets up six simple steps to streamline a lubrication program and points out that for many plants a maximum of six lubricants will do the job. The Pure Oil Co.

## INSULATION, LININGS

**134 Specifications on Thermal Insulations** — Specification sheets covering 32 surfacing thermal insulations for both high and low temperatures are accompanied by a 4-pp guide to their use. This handy index charts various types of heated and refrigerated equipment, cold water and dual-temperature lines and vessels, and ducts, along with surface conditions to be met, showing available specifications in each of the major insulations, i.e. fibrous glass, calcium silicate, air cell etc. Benjamin Foster Co.

**135 To Wrap Around Pipes** — This 8-pp booklet describes Aerowrap, a wrap-around insulation for hot or cold pipes of all sizes and also adaptable for application to valves, fittings and irregular pipes. Advantages of this blanket-type insulation are outlined, procedure for application is shown. Owens-Corning Fiberglas Corp.

**136 Rubber Linings** — This 8-pp illustrated bulletin tells advantages and application of rubber lining to steel tanks, drums, pipes, valves, fittings and pumps. Includes tables giving resistance characteristics of company's rubber lining to inorganic acids, salts and alkalies, organic materials, other materials. Protective Coatings, Div., Metalweld, Inc.

### . . . *Outstanding Among This Month's Catalogs*

**137 New Engine Developments** — Bulletin S-500-B55, 12 pp, presents new developments in oil diesel, dual fuel diesel and high compression spark ignition engines. Describes features of modern, economical, heavy duty, internal combustion engines. Includes a heat balance chart showing waste heat recoverable from exhaust gases and jacket cooling water; and is accompanied by fuel cost charts and descriptions of installations utilizing heat recovery systems. Engine Div., Worthington Corp.

**138 Measurement in Distribution Systems** — "Solving Distribution System Problems through Measurement" is a 20-pp booklet aimed at easing complex problems met in distribution, transmission and substation engineering. Deals with use of measurement instruments in obtaining continuous accurate information as to conditions at key points of a system. Explains how measurements of determining factors, which serve as a guide in solving system operating problems, can be made practically and economically. Sangamo Electric Co.

## OTHER EQUIPMENT

**139 Modern Stockpiling** — Twenty-pp Book 18 titled, "Big Coal Storage Capacity Right Now," tells how it is possible to stockpile all the coal required by using company's rubber-tired Tournapulls and Tournadozers. Pictures their use at many industrial plants and includes index chart covering examples of various types of operations. R. G. LeTourneau, Inc.

**140 Plumbers', Steamfitters' Tools** — Catalog 353, 12 pp, describes and illustrates a complete line of tools for plumbers, steamfitters and machinists. Provides complete technical data, and includes price list. Covers wrenches, pipe vises, threaders and cutters, bar vises. The Erie Tool Works.

**141 Structural Steel Flooring** — Open steel grating and stair treads are the subject of 24-pp Form 44. Describes and pictures riveted and welded types for flooring, stairways, platforms, walkways, mezzanines, tower stairs, boiler rooms, warehouses and many other applications. Provides specifications, load tables, includes installation photos. Klemp Metal Grating Corp.

**142 Tubing Steel for High Temp Service** — An alloy tubing steel for elevated temperature service is discussed in Technical Data Card 146. The steel is company's Croloy 5 (4 to 6 per cent chromium, ½ per cent molybdenum) said to be particularly resistant to corrosion from hot oil, hydrogen sulfide, elementary sulfur and sulfur compounds. Bulletin gives data on properties, creep strength. Tubular Products Div., The Babcock & Wilcox Co.

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## HEAT EXCHANGING, COOLING

**201 Heat Exchangers** — The advantages of film-type heat exchangers in the solution of cooling water problems, even when dirty water must be used, are stressed in Bulletin HE-7, 8 pp. Explains and illustrates design details. Discusses use of these heat exchangers in power plants, chemical plants, and in a compression plant. Henry Vogt Machine Co.

**202 Finned Tube Heat Exchanger** — Bulletin 1400, 20 pp, fully describes the company's G-R Twin G-Fin Section heat exchanger. The unit has wide application for heating and cooling liquids and gases, and for condensing vapors, according to the company. Suitable as boiler feedwater preheaters, fuel oil heaters, etc., features of design and construction are given. Griscom-Russell Co.

**203 Heat Exchanger for Process Industries** — Bulletin HF-101, 8 pp., describes the Holo-Flight Processor. Tells how this heat exchanger affords control of the flow of material as to duration of treatment, and control of the quantity and temperature of heat exchange agent. Western Precipitation Corp.

**204 Air-Cooled Heat Exchangers** — Technical Bulletin R-53-DC1 is a 6-pp illustrated article on the economics of the air-cooled heat exchanger for process cooling. Discusses air-cooled exchangers and their selection, gives design details that affect cost and evaluates operating costs. The Marley Co.

## BOILERS, GENERATORS

**205 Improved Steam Generator** — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions and standard and accessory equipment for the units which range from 20 to 6000 hp, for pressures to 250 psi. Preferred Utilities Mfg. Corp.

**206 Shop-Assembled Boiler** — Sixteen-pp Bulletin G-76, completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. Savings in erection, installation and moving costs are stressed. Capacities, dimensions and weights given. The Babcock & Wilcox Co.

**207 Re-circulation Steam Generator** — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or where load fluctuates. Combustion Engineering, Inc.

**208 Steam Generators** — Twenty-pp Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Use of generator with various fuels and firing arrangements is covered. Erie City Iron Works.

**209 Steam Boilers** — Form SG 128-749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic crossection of four-pass design characteristic of company's boilers. Cleaver-Brooks Co.

**210 Scotch Marine Boilers** — Bulletin 236 illustrates and describes a Scotch type of boiler on skids suggested for a wide range of applications. This boiler can be hand- or stoker-fired with coal or can use oil, gas or wood as fuel. Gives construction details, stresses versatility, other advantages. Includes test data and specifications. The James Leffel & Co.

**211 Oil or Gas Fired Automatic Boilers** — Boiler, burner, controls and safety features of 10 to 500 hp oil or gas fired automatic boilers are described in this bulletin. Firing rates, dimensions and capacities are given for all models along with installation photos of some models. Boiler Engineering & Supply Co.

## GAS AND OIL BURNERS

**212 Gas Burners** — Illustrated Bulletin 410-8, 16 pp, furnishes descriptive and technical data on company's gas burners and combination gas and oil burners, giving design details and explaining operation of each. Coppus Engineering Corp.

**213 Oil Burning Equipment** — Bulletin O-B 37 contains 16 pp of technical information on company's oil and gas burning equipment, steam atomizing burners, mechanical atomizing burners, interchangeable burners, telling best applications, including capacity data. Also shows fuel oil pumping, heating systems. The Engineer Co.

**214 Steam Atomizing Oil Burners** — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. National Airoil Burner Co., Inc.

## TUBING AND ACCESSORIES

**215 Condenser Tubes** — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the

(*Continued on page 142*)

JUNE 1953
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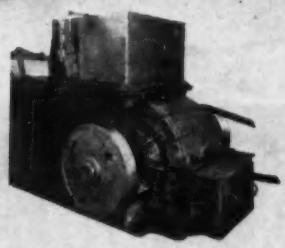

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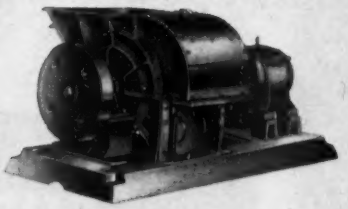

**"S" Series.** 9 sizes. Capacities up to 500 TPH. High tonnage with minimum fines. Well suited to power plants.

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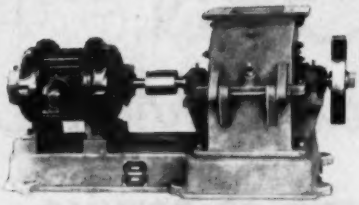

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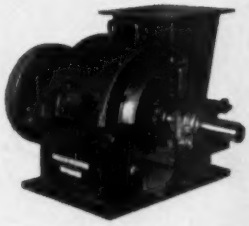

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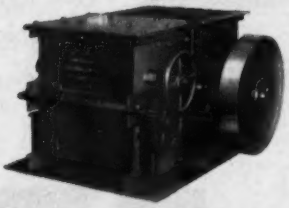
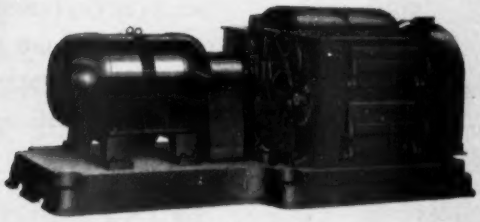


**"WC" Series.** 4 sizes. Capacities up to 90 TPH. Available with drop cage. Compact, requires minimum headroom.



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A single Hagan Ring Balance Meter can measure one or two differentials to 420" WC at static pressures up to 3,000 psig, or differentials to 140" WC up to 15,000 psig. Automatic correction can be applied for such variable factors as fluid temperature, pressure or density. Indicating, recording and integrating features are standard. Flows may be added, subtracted or controlled in a manually adjustable ratio. Pneumatic signal transmitters are standard.

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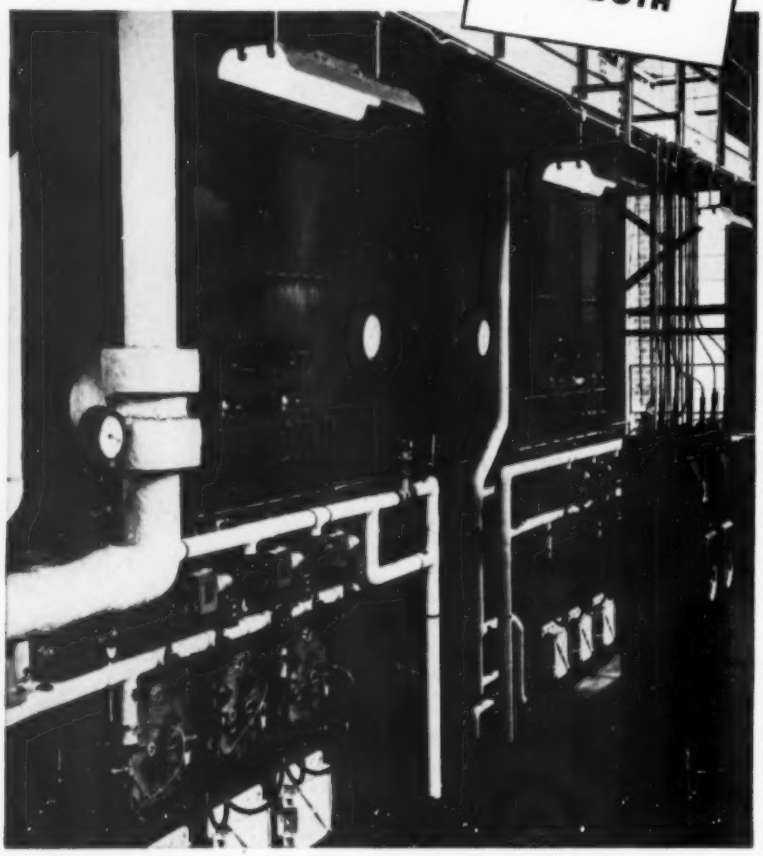
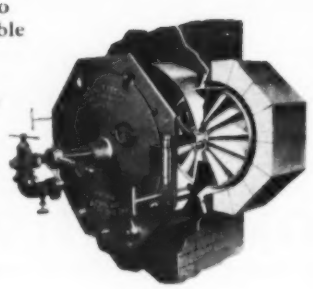
FOR OIL, GAS OR BOTH



This New England textile mill uses Enco Type K oil burners. When gas is available a gas-burner gun can be added for dual fuel firing.
Combustion in any case is uniform even if steam demands fluctuate suddenly—another economy feature.
This is only one example of economy with Enco Burners—made in sizes and types for every power plant need, including those with very wide load swings. Ask for literature or a special recommendation for your specific, individual oil or gas burner needs. We will give it the benefit of 35 years' experience in solving unique burner problems.



Enco type K
oil burning unit

EC-489

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## Feedwater Equipment

*(Continued from page 123)*

relatively large diameter — probably three or four times the diameter of the drain pipe take off. At least part of the venting to atmosphere or elsewhere should be taken off near the water level in such a sump.

Wherever there may be a differential of more than say 2 in. water gage along the length of a horizontal heater shell the drainage points must be located in the low pressure end.

### Flashing

Irregular drain action is possible where full temperature drains are discharged into lower pressure spaces. There will always be flashing and pipe sizes must be planned to suit. Pipes should be sized one or two steps larger than for solid water. At this point it must be recognized that any tall column of water if at boiling temperature at the base will flash within itself even when the control valve is at the top. This may induce unstable flow as well as cause mechanical trouble.

The inter-relation of drains and vents becomes apparent here. Vents must remove all non-condensables and therefore need to be located close to the normal water line. Erratic drainage may clog the vents with water. New layouts often have drip coolers as stabilizers.

### Thermal Drainage Controls

Whenever a thermal type drain control is used it must have steam — not gas — above the water in its active element. This steam connection must not only be in the correct pressure zone but where it will not become "air bound."

In new installations the discharge of heater venting is usually disposed of either through vent condensers on deaerators or the air extractors on deaerating condensers.

Older installations usually can be piped up to accomplish the same effect. If this is not practicable, attention must be given to venting enough and at the same time to blow away a minimum of the steam.

In no case should the non-condensables be reabsorbed and returned to the main stream.

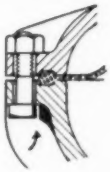
A point sometimes overlooked is disposal of the drainage from vent condensers. This water, being exposed to non-condensable gases at temperatures far below the boiling point, is always poisonous to otherwise high purity steam. It should, if practicable, be returned to the deaerating equipment so as to be recirculated through the whole deaerating process. This is commonly a built-in feature of new equipment but it may require some ingenuity to accomplish when adding a vent condenser on old heaters.

A later article will deal with the rehabilitation of open feedwater heaters.

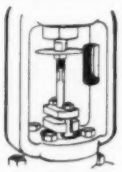
# Single wrench maintenance

## check these time and money-saving maintenance features

**1** **CAST FLATS** make bolts easy to remove on superstructure. Heads can't turn . . . only one wrench needed.

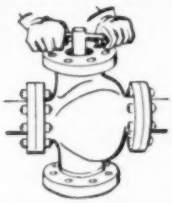


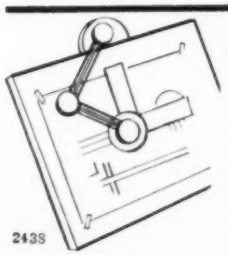
**2** **WIDE YOKE**—plenty of room for big hands to work with that one wrench.



**3** **FLATS** on valve stem use same adjustable wrench—does not score stem.

**4** **SEAT RINGS** can be renewed without taking the valve body from the line. No vises, no lathes. Standard Leslie practice for 27 years, not a theory, a proven fact.





**5** **INTERCHANGEABLE** parts keep inventory small, reduce down-time. Top grade materials and engineering means less maintenance.

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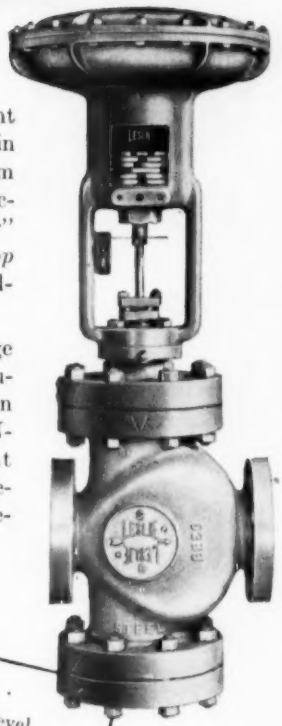

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## Industrial Power Plants

*(Continued from page 73)*

Comments, when made, were similar to those outlined above, but emphasized the need for proper sizing to avoid excessive maintenance costs resulting from overloading, also the necessity of a competent maintenance crew. It was felt that a better standardized method of rating would be very desirable.

### Three Plants Remodeled

Three installations planned as outlined in the earlier portion of this discussion, with return tubular boilers replacing old boilers disrated by the insurance companies, have recently gone into service with very satisfactory results. Experience during somewhat more than a year has indicated that operating costs have been substantially reduced, although plant records previous to the change are too incomplete to provide definite figures.

Data on installation cost are available, however, and are stated hereafter.

**Plant A** — This is shown in Figs. 1 to 4 inclusive. Manufacturer of small metal wares. Old plant six 72 in. x 18 ft hrt boilers fired with flat-flame steam-atomizing oil burners, steam pressure 70 psi.

Replaced by three 84 in. x 18 ft hrt boilers, solid refractory settings with automatic, forced-draft, pressure-atomizing, oil-burner units. Estimated maximum continuous steam load 24,000 lb per hr, 4-hour overload capacity 27,000 lb. per hr, one boiler as a spare unit. Installation included a new radial brick stack 6 ft diameter, 125 ft high with foundation; new deaerating feed water heater capacity 36,000 lb per hr with 6,000 lb storage; new duplex boiler feed pumps and gasoline-engine-driven emergency generating set. Space provided in building for an additional boiler unit. Existing building and fuel oil storage tank were utilized. Total cost including engineering fees: $140,000 or $3.89 per lb per hr for 36,000 lb per hr installed steaming capacity.

**Plant B** — This is shown in Figs. 5 to 8 inclusive. Manufacturer of hardware. Old plant, sixteen 72 in. x 18 ft hrt boilers, hand fired with coal; steam pressure 150 psi, Corliss-engine-driven generators discontinued, all power purchased from public utility. Replaced by six 72 in. x 18 ft hrt boilers air-cooled furnace walls and floor, with forced-draft, steam-atomizing oil-burner units. Estimated maximum continuous steam load 50,000 lb per hr, no overload guarantees, one boiler as a spare unit.

Installation included two 30,000-gal oil tanks with concrete enclosure, pump and heater set, piping, etc. Also a 50,000 lb per hr deaerating heater, with 12,500 lb storage capacity, condensate storage tank and

*Pressure Reducing Regulator for Liquids and Gases*

For regulation of fluids where corrosion and contamination are problems, Foster Automatic Valves are now available in all-stainless construction.

All valve parts in contact with fluids may be had in a wide range of corrosion resisting alloys.

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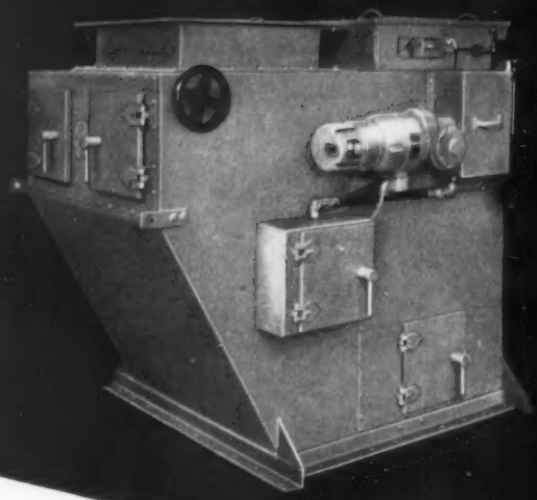
booster pump. Existing building, stack, flues and boiler feed pumps were utilized. Total cost including engineering fees: $175,000 or $2.92 per lb per hr for 60,000 lb per hr installed steaming capacity.

**Plant C** — Nonferrous metal rolling mill. Old plant, six 78 in. x 18 ft hrt boilers, three coal fired with hand stokers, three oil fired, steam pressure 125 psi. Corliss engine drives discontinued, motors operated on power purchased from public utility substituted. Boilers replaced by three 84 in. x 18 ft hrt boilers with solid refractory settings and forced-draft, rotary-cup, atomizing oil-burner units. New deaerating feedwater heater, capacity 40,000 lb per hr with 10,000 lb storage, new boiler feed and condensate return pump; also gasoline engine driven emergency generating set. Existing building, stack, flues, piping and oil storage tanks were utilized. Estimated maximum load 30,000 lb per hr, one boiler spare. Total cost including engineering fees $107,000 or $2.38 per lb per hr for 45,000 lb per hr steaming capacity.


NEW Richardson
H-39 COAL SCALE



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## New ENGINEERING BOOKS

**Piping Stress Calculations Simplified.** By S. W. Spielvogel. 114 pages, 9 by 11½ in. Flexible binding. Published by S. W. Spielvogel, Lake Success, N. Y. 1951.

The calculation of pipe stress under changing temperature conditions is an extremely important element in the design of modern industrial piping systems. In years past such calculations were made only by engineers having an extensive practical background and working knowledge of calculus. This book, however, presents methods which enable practical men to solve piping problems without such knowledge of calculus.

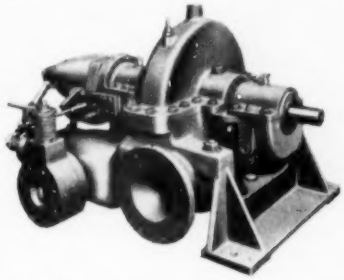
Methods for calculating expansion stresses in high-temperature power piping have been worked out in a number of ways by several investigators, and engineers engaged in this field have adopted one or another of these procedures, depending on personal preference or extent of theoretical background. Material in this book by Mr. Spielvogel applying to one such method is discussed in sufficient detail so that the mathematical theory can be traced from principle to actual calculation of typical problems. Exact solutions have been worked out in arithmetical form so that the practical pipe designer can refer to typical problems for both form and method of computation. Fortunately it is possible to strip the mathematical formulas to a point where the practical pipe designer can recognize the results without need for following the detailed derivations.

# "This engineered oil cushion prolongs turbine bearing life"

Tests on standard ring-oiled bearing construction show that oil being flung off at high shaft speeds was lost to lubrication. An exclusive Westinghouse-designed Wiping Shield solves this by directing the oil back on the bearing. This results in more oil on the bearing . . . enabling it to stay in service for extremely long periods and stand up under severe running conditions. Soundness of this reinforced oil cushion was proved right in the bearing itself by imbedding thermocouples throughout the babbitt. When measured during exhaustive floor tests, temperatures showed total elimination of "hot spots".

This important refinement exemplifies the thoroughness of Westinghouse continuing program to build more and more efficient prime movers. A program based on—over 50 years' experience in turbine design and manufacture . . . research and development skill . . . complete production facilities . . . full-scale floor testing . . . quality components . . . wide range of capacities, from 1 hp to the largest made . . . and expert field and application ability.

## The Type E General-Purpose Turbine



Type E-116 is the smallest member of the Type E family and is rated up to 500 hp. It is a typical product of Westinghouse engineering progress and includes these important features: dual protection against overspeed; weather-resistant construction; centerline support and interchangeable parts. Other Type E sizes are also available, with ratings through 1500 hp, to cover a wide variety of applications.

Consult your Westinghouse Sales Representative who is well equipped to assist in specifying the correct size and accessories for maximum economy, operating efficiency and dependability; or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50553

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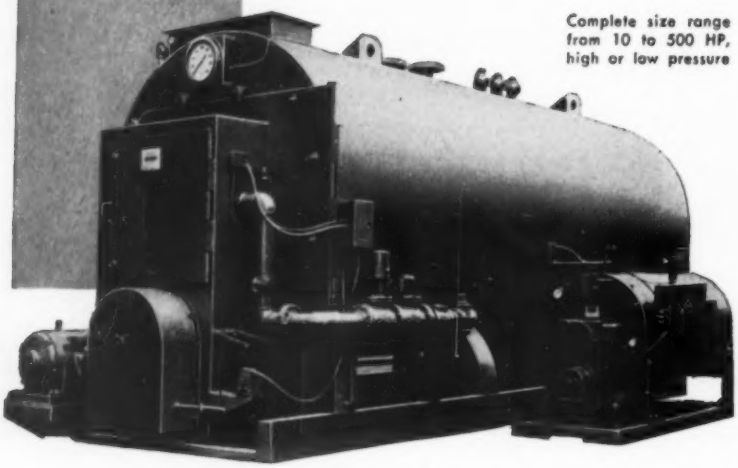

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Continental Automatic Boilers are of rugged, built-to-last construction and improved precision design gained by 40 years of practical boiler building. Hundreds of these highly efficient boilers are setting records in economical, dependable and trouble-free service throughout the U.S. and Canada.

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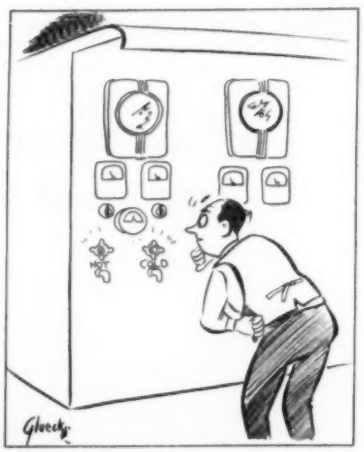
The book is arranged in such a manner that one familiar with pipe calculations can refer quickly to formulas or computations involved in any specific case without reviewing the theoretical background. Computation forms are arranged to permit sharing of labor on three-dimensional piping systems by allocating parts of the work to several persons. The method is exact within slide-rule accuracy.

An excellent book from any standpoint. It brings the ordinary layout problem well within the grasp of many who wish practical answers to immediate piping layouts.

**Proceedings of the National Electronic Conference** — Volume VIII. 865 pages, 6¼ by 9¼ in., cloth. Published by the National Electronics Conference, Inc., 852 E. 83rd St., Chicago 19, Illinois. 1953. Price $5.00.

Each year the complete proceedings of this conference is published in book form. This volume of the 1952 proceedings, contains, with only one exception, the complete text of all the technical papers and luncheon speeches presented at the conference. It covers a tremendously wide range of papers relating to the theory and application of electronics in both the communication and industrial fields. An idea of this range may be had from the following list of section headings: Servomechanism Theory, High Frequency Electron Tubes, Audio, Industrial Measurements, Magnetic Amplifiers and Servo Applications, Television, Equipment and Components Reliability, Waveguides, Transistors, Radio Navigation, Radar, and UHF Transmitter, Circuits, Components, Assembly and Measurements, Semiconductors, Memory Tubes and Tube Reliability, Computers, Antennas, Electronic Instrumentation, Engineering Management, Coding and Recording Techniques, Delay Lines and High Frequency Test Equipment.

**How To Improve the Utilization of Engineering Manpower,** prepared by the National Society of Professional Engineers under the direction of the Professional



# HALL INDUSTRIAL WATER REPORT

*Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.*

Volume 1 | JUNE 1953 | Number 3


## *Boiler Scale Formation And Control Subject Of Paper by Rivers*

In a recent paper, "Concentrating Films: Their Role in Boiler Scale and Corrosion Problems," H. M. Rivers, Director of Engineering Service for Hall Laboratories, discusses the theory of how and why highly concentrated films form on steaming surfaces, the mechanism of steam generation and scale formation, characteristic effects of concentrating films, and problems associated with degree of film concentration.

Mr. Rivers points out that water consultants are responsible for treating boiler water so that concentrating salts do not crystallize out of solution, or precipitate in forms which will accumulate continuously as solid deposits. Further responsibility: natural constituents or added chemicals in boiler water must not give trouble because of decomposition or volatilization under "film" conditions; and corrosive concentrations of free caustic must be safely avoided.

On the other hand, boiler makers must design for heat input rates which limit tendency toward excessive concentrations, and provide adequate circulation and turbulence to assure rinsing of all steaming surfaces.

Write for your free copy of this informative paper.

## *Radar Plots Course Of Illinois' Water*

The greatest water resource of the State of Illinois lies in the air moving across it, Dr. A. M. Buswell, chief of Illinois State Water Survey, reported at the recent American Power Conference.

Radar tracks the release of this water to land surface as rain from thunderstorms. Not only are storm paths logged, but the amount of rainfall can be estimated.

Accumulation of such data provides a basis for future efforts to trap more rain.

# CONSULT WATER SPECIALISTS BEFORE BUILDING!

### *Future Water Problems are solved in planning stage*

Calling in the specialists of Hall Laboratories before a plant is built can save many dollars and much time. Hall engineers study plant requirements and needs, and come up with important recommendations which can then be incorporated in the plant as it is built.

Consider a recent instance. Hall was called in by the consulting engineers of a large, New York State manufacturing company that had decided to construct a plant in California. The problem involved was the proper treatment of the local city water supply, for use in boilers at the new plant. Changes in the available water would occur frequently due to the mixture in the system of water from four different sources, all varying widely in composition. These changes could markedly alter the composition of the plant's water supply within less than an hour's time.

To properly prepare this water, a flexible pre-treating system was recommended by Alex Henricks and approved by his associates on the Hall headquarters staff. Designed to insure good quality water under any conditions, the equipment suggested was simple to operate and sized so that capacity would be adequate regardless of incoming water composition; yet frequent attention would not be required to keep the system in proper operation.

## *Industrial Water Problems Require Special Handling*

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., P.O. Box 1346, Pittsburgh 30, Pa.

*Water is your industry's most important raw material. Don't waste it.*

## *Water Important Topic Of ASME Meeting in L. A.*

Major interest appears to focus on three papers dealing with corrosion produced by condensed steam, but other water problems are not neglected at the two sessions sponsored by the Joint Research Committee on Boiler Feedwater Studies and the Power Division at the mid-year meeting of the American Society of Mechanical Engineers at Los Angeles, June 29 to July 3.

## *Woolen Yarn Dyer Improves Cleaning, Dyeing Operations With Hall Technique*

Unsatisfactory yarn scouring, plus the intermittent need for 35% more acid in dyeing operations than tests indicated should be needed, plagued this yarn dyeing concern, a new client of Hall Laboratories.

Noting that dye kettles were heated with direct-contact steam from a low-pressure boiler, the Hall engineer checked steam for carryover of alkaline boiler water. At peak load, samples were heavily contaminated; even at normal load, carryover was appreciable.

The Hall engineer recommended using Hagan Anti-Foam to reduce steam contamination. Now, even for heaviest loads, steam contains less than 3 ppm dissolved solids, higher boiler water solids are carried with resulting savings in water, heat, chemicals.

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Spherically ground Dart seats say "no" to leaks as long as in service — and as often as piping is changed. Darts can be taken off the line and used elsewhere time and time again. That's economy! What's more, the tight seal comes easily without heavy wrenching or strain.

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Engineers Conference Board for Industry; 56 pages; 6 x 9 inches; paper binding, published by Professional Engineers Conference Board for Industry, 1121 15th Street, N. W., Washington 5, D. C. Price: $2.00.

This is Executive Research Survey No. 2 issued by this organization, the first one being How To Improve Engineering Management Communications, published some time ago.

In the present study is pooled the experience in utilization of more than 500 leading industrial companies and engineering organizations, employing some 106,000 engineers and a total of 2,750,000 people.

It is a guide book and manual for the executive in companies and organizations employing engineers and engineering services. For the engineer or the student and the engineering educator as well, it is an appraisal of the values of better utilization of engineering manpower.

The book covers such phases of the subject as indoctrinating engineers, making the existing engineering staff more effective, use of supporting personnel, and then asks are engineers' talents being wasted? This is followed by a discussion of auxiliary sources of engineering talent, engineering turnover, preparing the engineers of the future, and how to improve their utilization, with summary and recommendations.

**Standards of Steam Condensers,** by the Heat Exchange Institute. Size 8½ by 11 in.; paper binding, 18 pages, illustrated. Published by the Heat Exchange Institute, 122 E. 42nd St., New York 17, New York. Price $2.00.

This is a revision of the book on the same subject, issued in 1939 and 1940 and is one of a series of 8 separate publications on different units of Heat Exchange apparatus.

The new book has been completely rewritten and revised. Definitions have been clarified. New material has been introduced as a result of extensive tests conducted by the Institute to arrive at values that would represent maximum safe design limits. This is necessary to establish heat transfer rates, possible of attainment under commercial operating conditions with efficiently designed condensers.

Tests were conducted at LcHigh University and the new data reflect the result of them including corrections for different tube materials. Performance curves have been included to illustrate more nearly actual maximum performance. A new section of recommended sizes is included. The recommended vacuum pump capacities have been revised and recommended capacities for rapid evacuation are included.

Object of these standards is to help the purchaser of condensers by defining essential terms and by setting up definite standards of heat transfer rates and performance guarantees. It also contains material essential to engineers when writing specifications or designing surface condensing equipment. In short, anybody having to do with the design, operation, and maintenance of condensers

will do well to have a copy of this book on hand.

**American Standard Machine Papers,** Number ASAB5.10 — 1953. Self-holding and Steep Paper Series, 8½ by 11 in.; paper binding, 16 pages, illustrated. Published by American Society of Mechanical Engineers, 29 West 39th Street, New York 18. Price $1.00 (Attention of Order Department).

All engineers who have to be concerned with producing machine papers, either in production work or in maintenance work, should be aware of the latest edition of these standards. They have gone through a number of tentative drafts, beginning in 1922, and the latest revision is approved as of March 30, 1953.

The standard establishes American Standard Practice for the Slope of Self-holding and Steep machine paper, detailed dimensions for this type of taper tool shank, corresponding dimensions for the taper socket in the spindle of the machine, including the dimensions of key ways.

The purpose of the machine taper of course is to provide a connection between the tool arbor, or center, and its mating part which will insure and maintain accurate alignment between the parts, yet permit them to be readily separated for reconditioning or for substitution of other parts.

The proper nomenclature is given in the standards, with tables and illustrations of the various taper series and key drives.

**Non-Ferrous Physical Metallurgy by R. J. Raudebaugh.** Size 9 by 6 in.; 345 pp including index; illustrated; cloth bound. Published by Pitman Publishing Corporation, 2 W. 45 St., New York, N. Y.; 1952. Price $6.50.

Recent developments in processing and fabrication of non-ferrous metals and alloys as well as the fine points of non-ferrous metallurgy are offered by this book.

Physical and mechanical properties of some of these are presented in tables. A table offering the periodic classification of some of the elements, along with the electron configuration and known isotopes appears in the book.

The text also includes equilibrium diagrams. In addition to this, micrographs of commercial alloys are presented.

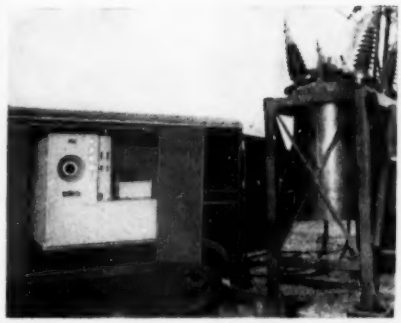
Aluminum and its alloys, magnesium and its alloys, nickel and nickel alloys, powder metallurgy and refractory metal composites are some of the chapters in this book.

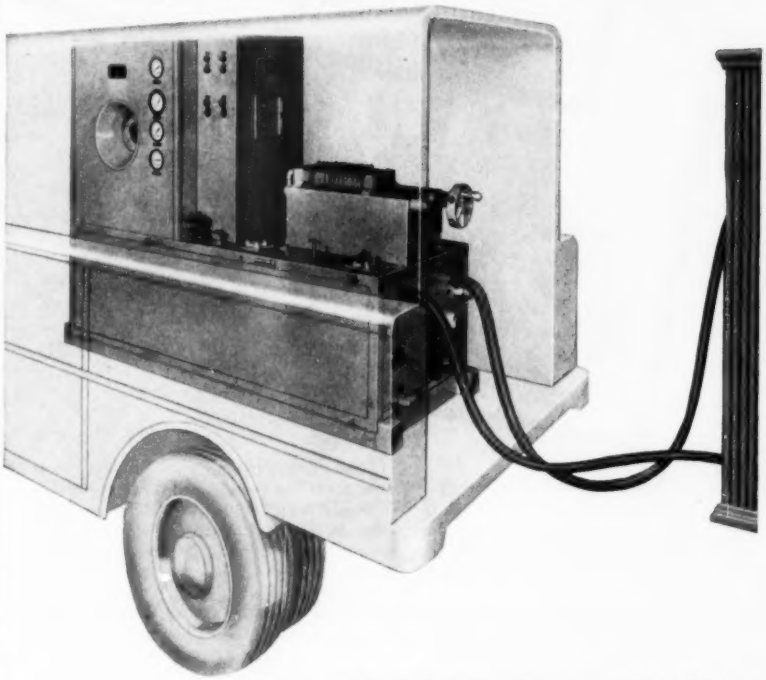
**Air Conditioning.** Perforated data sheets; size 6½ by 3¾ in.; Published by Lefax, Sheridan Bldg., Philadelphia 7, Pa. Price $1.00.

This is one of a number of data sheet collections that are available on various engineering subjects. These handy notes can be carried on the job where they can be ready for quick reference.

This collection offers selected material on the subject of air conditioning and contains charts, tables and information on equip-


NO service interruptions





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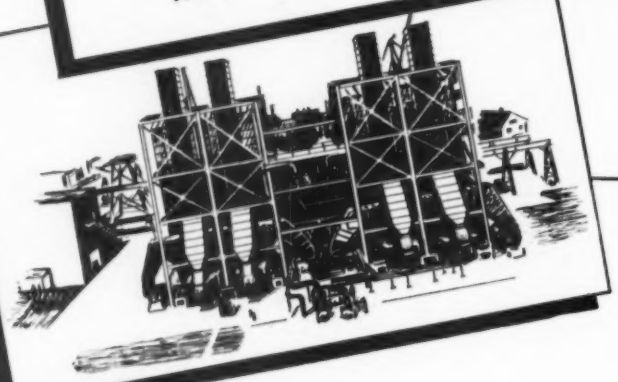

Houston Lighting & Power Company is a leading factor in the power field of the great southwest. That it approved the selection of Green Draft Fans by the boiler manufacturer — in this case Riley Stoker — is evidence of high acceptance in the field. No utility can afford to operate with inferior or unsuitable equipment at *any* point. It must have equipment that is not only highly efficient but right.

To Houston Lighting & Power can be added other well-known recently completed utilities that are Green Fan plants, among them the following:

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Louisiana Power Light Co.
Kansas Gas & Electric Co.
El Paso Natural Gas Co.
Pacific Gas & Electric Co.
South Carolina Public Service Authority
Buffalo Niagara Electric Corp.

With utilities as with industrial power plants, it's safe to "Go on Green" when it comes to draft fans.

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ment as well as the technical aspects of the subject.

These are the titles of several of the inserts: heat insulation in air conditioning; selection of fans for pipe ventilation; operating and servicing air conditioning systems, and ventilation with air conditioning in modern buildings.

**Introductory Nuclear Physics,** by David Holliday. First Edition; 558 pages; 5½ by 8½ in.; illustrated; cloth; published by John Wiley and Sons, Inc., 440 Fourth Ave., New York, N. Y.; 1950. Price $6.50.

This book expounds the philosophical aspects of nuclear physics besides integrating problems and modern points of view. In general, Professor Holliday discusses nuclear physics as it is today, the historical development having been largely ignored. While the book is designed as a textbook for a beginning graduate course in nuclear physics, as the author points out, by omitting material in fine print, it can also be used for an advanced undergraduate course.

An idea of the scope of the book may be had from the following chapter headings: 1 — Basic Nuclear Concepts; 2 — Alpha and Gamma Emission; 3 — Electrons in Disintegration Processes; 4 — Interaction of Charged Nuclear Radiation and Photons with Matter; 5 — Detection of Charged Particles and Photons; 6 — Neutrons — Production, Detection and Interaction with Matter; 7 — Nuclear Mass Numbers and Mass Abundances; 8 — Nuclear Forces; 9 — Charged Particle Accelerators; 10 — Nuclear Reaction; 11 — Nuclear Fission; 12 — Cosmic Rays; 13 — Nuclear Spin and Magnetism.

The subject is treated descriptively rather than from a rigorous mathematical standpoint. Abundant tables and key references to modern literature are included and there is a great abundance of illustrations.

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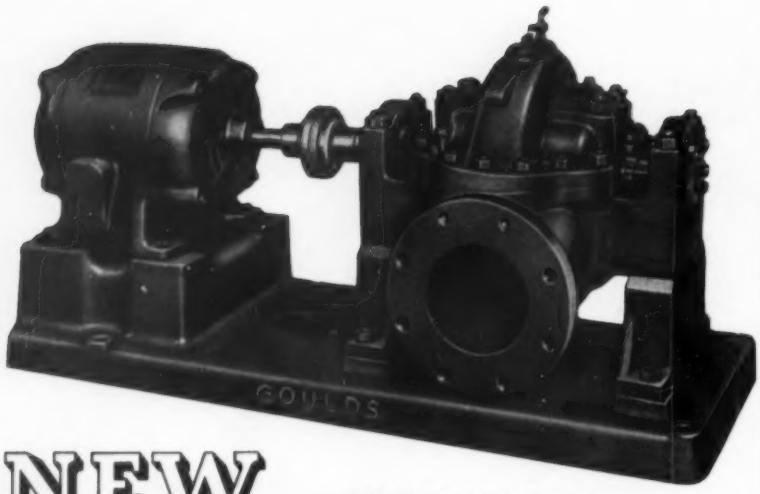


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c. Cowl-type glands suitable for use with quenching liquid.
d. Stainless-steel impeller keys.
e. Teflon water-seal rings.
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g. Corrosion-resistant gland bolts.

**2** ***Interchangeability of parts.***

Only three shafts and rotating parts assemblies provide for 19 pump sizes. This means you get:

a. Great flexibility in making field changes.
b. Low initial cost due to standardization of manufacture.
c. Reduced spare parts inventories.

**3** ***Saves floor space.***

Short bearing spans cut over-all lengths as much as 50%.

**4** ***Flexibility of stuffing box.***

You can use either conventional stuffing boxes or mechanical seals —and change from one to the other.

**5** ***Easy rotation change.***

You can change from right- to left-hand rotation or vice versa in the field without construction change because of an unique device locking shaft sleeves.

***GET FULL DETAILS*** **from the 12-page illustrated bulletin, No. 721.6, covering the complete details of the new Goulds Fig. 3405, including specifications, interchangeability tables and performance curves. Be sure you have the whole cost-advantage story before you select another general purpose pump. Contact your nearest Goulds representative or write to Goulds Pumps, Inc., Seneca Falls, N. Y.**

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## CATALOG LIBRARY

(*Continued from page 126*)

selection of tube materials, and the composition and physical properties of company's alloys. Details on proper installation are presented, as are specifications, conversion tables, weights of tubes and alloys. Scovill Mfg. Co.

**216 Life Extension for Condenser Tubes** — This 32-pp extensively illustrated booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

**217 Nickel Pipe and Tubes** — Bulletin T-17 is a 27-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

**218 Double-Walled Tubing** — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators. Discusses heat transfer properties, high temperature use. Bridgeport Brass Co.

**219 Tube Cleaners** — Catalog 76-A provides 48-pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Electrically driven equipment, air valves, hose, lubricators presented. Thomas C. Wilson, Inc.

**220 Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads discussing special features. Roto Div., Elliott Co.

**221 To Avoid Tube Corrosion** — Bulletin TR-514 is an 8-pp illustrated article discussing corrosion as a major factor in shortening the life of boiler tubes. Indicates that, in low pressure boilers, corrosion is the largest single cause for replacement of tubes. Points out types and causes of corrosion and gives general rules to follow to get maximum service life from boiler tubing. Tubular Products Div., The Babcock & Wilcox Co.

### COAL, ASH HANDLING

**222 Where Refuse Is Fuel** — Presented in 24-pp Bulletin are installations of company's stokers with medium-size and larger units burning refuse fuels, separately or in combination with coal. Lists many of the refuse fuels handled successfully by this type of spreader stoker. Detroit Stoker Co.

**223 Economic Coal Storage** — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses

flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; picture several models. Tractor Div., Allis-Chalmers Mfg. Co.

**224 Spreader Stoker Data** — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

**225 Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

**226 Shredder Ring Crusher** — A crusher for coal and similar materials which features rolling shredder rings is described in this 8-pp bulletin. Gives details on a survey of 29 mines and power plants in which this type crusher is installed. Informative tables giving speed, capacity, horsepower, weight and dimensions of crushers, as well as cost data are included. American Pulverizer Co.

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**227 Automatic Coal Scale** — Sixteen-pp Bulletin 0352 describes an automatic coal scale for weighing coal as it is fed to boilers, enabling a power engineer to maintain a constant check on boiler efficiency. Book gives construction and operating details on the belt feeder, weigh hopper, scale housing, operating levers and accessories. Photos and line drawings show scale features. Richardson Scale Co.

**228 Why Liquid Diffusion** — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March.

## FUEL OILS, LUBRICANTS

**229 Cooperative Technical Consultation Service** — This informative 24-pp booklet presents company's periodic consultation service aimed at the most efficient use of petroleum products. Covers services available in the solution of lubrication problems, metalworking operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

**230 Air Compressor Lubrication Manual** — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include


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*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

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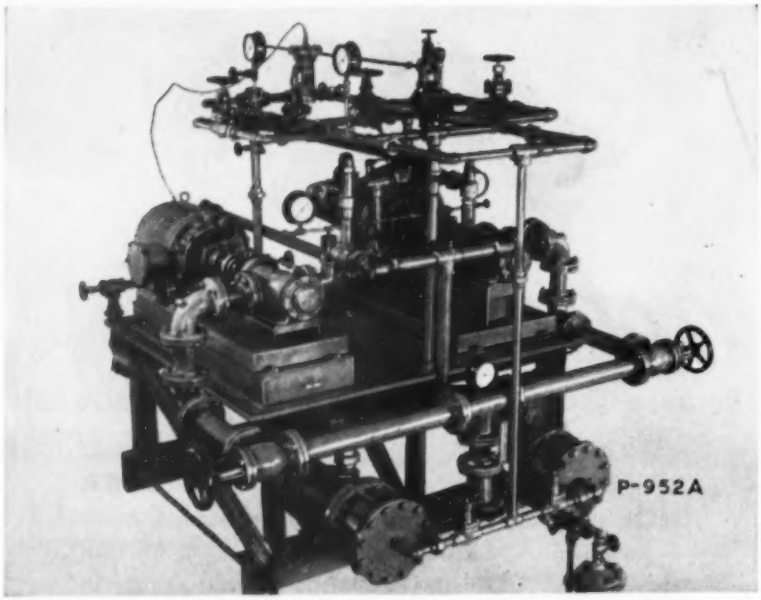


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compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, also safety precautions. Cities Service Petroleum, Inc.

**231 Diesels, Their Fuels and Lubricants** — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to their speed is also explained. Sinclair Refining Co.

**232 Versatile Industrial Oil** — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

**233 Turbine Lubrication** — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations, photos of purifiers. DeLaval Separator Co.

**234 Turbine Oil Conditioning** — Bulletin 832-P, 12 pp, offers a detailed explanation of the reasons for turbine oil conditioning, the way in which company's dry type conditioning equipment nullifies or prevents factors which promote deterioration of oil. Bowser, Inc.

### PUMPS, PUMPING

**235 Rotary Pump Service Manual** — The installation, operation and maintenance of rotary pumps are covered in 12-pp Service Manual 100-2. Subjects discussed include installing of foundation bolts, alignment, supporting vertical pumps, grouting, piping, suction lines, hot liquid pumps, rotation, packing, dismantling, reassembly, starting, operation and standing idle. Warren Steam Pump Co.

**236 Condensed Pump Data** — Form 4383-J covers more than 20 types of general service pumps, rotary pumps, sump and drainage pumps, condensate units, self-priming units, stainless steel pumps and high pressure pumps. In easy-to-find tabular form, each model is pictured along with its characteristics, applications, features and references to specific literature providing further information. Goulds Pumps, Inc.

**237 Controlled Volume Pumps** — Bulletin 351, 16 pp, describes company's air-powered controlled volume pumps, designed to pump practically any liquid in measured volumes accurate to within a fraction of 1 per cent. Pumps are reciprocating, positive displacement plunger types. Cross-sectionals show design and operating details. Controls and typical automatic feed systems are discussed. Milton Roy Co.

**238 Boiler Feed Pump** — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up, is the subject of 12-pp Bulletin

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1525. Fully illustrated text explains automatic operation of hydraulic thrust balance incorporated in this pump. De Laval Steam Turbine Co.

**239 For Controlled Volume Pumping** — Bulletin 300, 24 pp, describes Pulsafeeder piston-diaphragm pumps, stressing their no-stuffing box feature and noting that although basically a pump, this unit can do the work of a feeder, meter, instrument, filling machine, proportioner and sampler. Process Equipment Div., Lapp Insulator Co., Inc.

**240 Boiler Feed Pumps** — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, floating seal incorporated. Capacity data and vapor pressure tables included. Pacific Pumps, Inc.

## PACKINGS, GASKETS, SEALS

**241 Packings and Gaskets** — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

**242 Seals for Bearings** — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals, typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

**243 Packings for the Power Plant** — Designed as a quick-reference aid, one feature of this compact 6-pp guide is a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. Illustrated. Includes construction information, sizes. Johns-Manville.

**244 Long Wearing Piston Packing** — Form 4502, 8 pp, presents composition cups for packing pistons of air and hydraulic cylinders and reciprocating pumps. Engineering information covers properties, textures, temperature and pressure data, sizes. Darling Valve & Mfg. Co.

## VALVES, TRAPS, PIPING AND ACCESSORIES

**245 Safety Valve Engineering Data** — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, and also tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

**246 Check Valves** — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principle of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

**247 Valve Specialties** — Included in 90-pp Catalog A-50 is ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. Sec-

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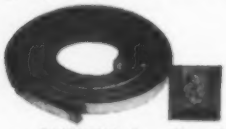

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tions are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves; pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Davis Regulator Co.

**248 For Quick Valve Selection** — Here's a 20-pp catalog digest providing ordering and application information on gate, globe, angle and check valves in bronze, iron, cast and forged steel construction, also valve accessories and parts. Illustrated and thumb indexed, includes pressure-temperature chart. The Ohio Injector Co.

**249 General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

**Postage-free cards for ordering these catalogs are on pages 35 and 126. When using them, don't forget to include your job title and company name—even if you want those catalogs to be delivered to your home address**

**250 Cast Steel Valves** — This 56-pp catalog on cast steel valves includes information on globe, angle and check valves in 300, 600, 900 and 1500 lb pressure classes. Parabolic disk valves for hand or motor control of volume are also described. In addition to standard information on construction features, dimensions and weights, the booklet contains complete data on material specifications, preparation of welding ends, flange facings, and ratings. Edward Valves, Inc.

**251 Gate Valves** — Literature is available on cast steel outside-stem-and-yoke gate valves; also on bronze, iron, steel and corrosion-resisting valves in a variety of types. The Wm. Powell Co.

**252 To Get at Those Valves** — This littie folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

**253 Regulating Valves** — Bulletin 313 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured body engineered for high capacity at low pressure drop. Leslie Co.

**254 Solving Steam Trap Problems** — This 36-pp catalog on steam traps contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps. The V. D. Anderson Co.

**255 Steam Trap Book** — Catalog J, 44 pp, serves as a manual of trapping prac-

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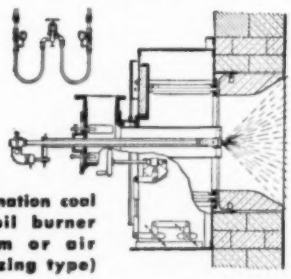

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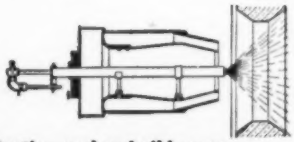

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tice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

**256 Steam Trap Reference Manual** — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure trap sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Yarnall-Waring Co.

**257 Steam, Air and Gasoline Traps** — Illustrated Catalog 751, 32 pp, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb, expansion steam traps, weight-operated traps for steam, air and gasoline, also piston-operated traps. W. H. Nicholson & Co.

**258 Piping Pointers** — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how to-do-it features. Includes 8 pp, valve selection guide. Crane Co.

**259 Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

**260 Handbook on Fittings, Flanges** — Catalog wf-1950, 68 pp, offers working information on seamless carbon steel welding fittings and forged steel flanges. Includes dimensional tolerances, thread standards and threading practice; service pressure ratings, physical and chemical requirements. Grinnell Co., Inc.

**261 Duplex Strainer** — This literature describes company's Duplex strainer with single handwheel control. Shows how it is designed with only one stuffing box and can be cleaned under full flow. R. S. Products Corp.

**262 Forged Fittings** — Literature is available on screw-end and socket-weld fittings. Stresses economy and other advantages of these fittings, lists steels available. Watson-Stillman.

## ELECTRICAL

**263 Electrical Maintenance Tips** — Booklet B-5477, 28 pp, gives a complete outline of preventive electrical maintenance. Discusses general maintenance programs designed to reduce shutdown time and treats in detail the maintenance of power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form. Essential information on preventive maintenance for turbines, generators, switchboards, motors and controls is provided. Westinghouse Electric Corp.

**264 Wire, Cable Ordering Guide** — Newly-released General Catalog W-52-3,

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Thanks to the proven dependability and completeness of the Clark steam trap and regulator lines, power engineers can meet most of their requirements simply by calling a Clark representative. For there's a "right" Clark steam trap for every purpose.

Clark makes the famous patented Duo-Step inverted bucket traps that handle *double* the usual amount of condensate. In addition, Clark manufactures open bucket and float type traps as well as pressure regulators and strainers.

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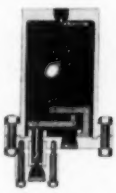

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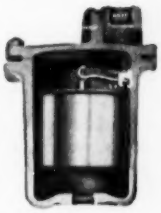

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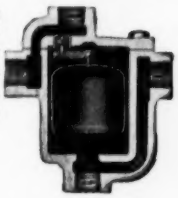

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186 pp, presents more than 500 different types of wires and cables. Contains comprehensive data on construction and operating characteristics for control and signal cables, cables for construction work, telephone wire and cables, and portable cords. A technical engineering data section is included. United States Rubber Co.

**265 Power Distribution Practices** — The 28-pp "Individual Power Distribution Idea Book" (Bulletin GEA 5900) is a guide on electric power distribution practices in large and small plants. Covers utility distribution practices; methods of buying electric power; what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; and types of load-center distribution systems. General Electric Co.

**266 Motor-Generator Reference Book** — Publication 51R7933 is a 50-pp booklet compiled to assist in the selection of motive power to handle most industrial applications. Neither text book nor ordering catalog, this book provides a brief outline of the various types of motors, generators and motor-generator sets, telling their applications and operating requirements. Booklet is generously illustrated and includes performance data, ratings, information on methods of speed control, general characteristics and representative dimensions. Allis-Chalmers Mfg. Co.

**267 Meet Microwave** — "An Introduction to Microwave," 20 pp, provides a semi-technical description of RCA microwave equipment and is illustrated with photos, charts, diagrams, etc. Describes microwave radio, tells how it works, gives propogation characteristics, operational advantages, economic factors influencing choice of frequencies, and desirable design characteristics. Also deals with multiplexing, telemetering and remote control features. Microwave Communications Section, Radio Corp. of America.

## WATER CONDITIONING

**268 Water Conditioning Data Book** — Recently revised, this pocket-size 116-pp booklet presents a compilation of 77 tables, all valuable to the power engineer. Covers such subjects as hydraulics, impurities in water, boiler feedwater make-up requirements, chemical conversions and chemical reactions. Contains excellent reference information on many phases and methods of water treatment. Available without charge to qualified power engineers. The Permutit Co.

**269 What's What on Ion Exchangers** — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, 8 pp, Super Nalcolite. State those wanted. National Aluminate Corp.

**270 Modern pH and Chlorine Control** — This 100-pp booklet gives details in color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water;

applications of water control in air conditioning; treating boiler feedwater. W. A. Taylor & Co.

**271 Steam System Treatment** — This bulletin on Coravol for prevention of corrosion, explains theory of corrosion, application of organic amines to steam systems (the Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing special chemical formulas for treatment of water, steam, brine and fuel. Western Chemical Co.

**272 Boiler Scale — Formation and Prevention** — Technical Paper 98 is a 12-pp article covering the cause and prevention of boiler scale. Covers the mechanism of scale formation, effect of boiler scale, chemistry of scale formation, internal chemical treatment and chemical correctives. Diagrams of feeder systems, photos and solubility charts illustrate text. W. H. & L. D. Betz.

**273 One-Minute Water Tests** — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50. Procedures, reagents, and equipment are described. Hall Laboratories, Inc.

**274 Water Conditioning Bulletin** — This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition. Wright Chemical Corp.

**275 Boiler Water Manual** — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and feedwater system, condensate returns. % Proportioneers, Inc. %

**276 Water Treatment** — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment, test control. Describes equipment. Dearborn Chemical Co.

**277 Feedwater Treatment** — Here is a 10-pp illustrated report on boiler feedwater treatment for a high-pressure, high-makeup power and steam producing plant. It is based on studies to determine best method of meeting requirements for both the high-pressure steam used in power generating turbines and the district heating steam for downtown Philadelphia. Graver Water Conditioning Co.

**278 Microbiological Control** — Technical Article 3C, 12 pp, is an illustrated discussion of microbiological control of and through industrial waters. A section on industrial water chlorination covers cooling waters and process waters. Other sections deal with chlorine metering in chemical processes, and the sanitary aspects of industrial water treatment. Wallace & Tiernan Co., Inc.

## INSTRUMENTS AND CONTROLS

**279 Supervisory Instruments** — Catalog 90-2, "Supervisory Instruments


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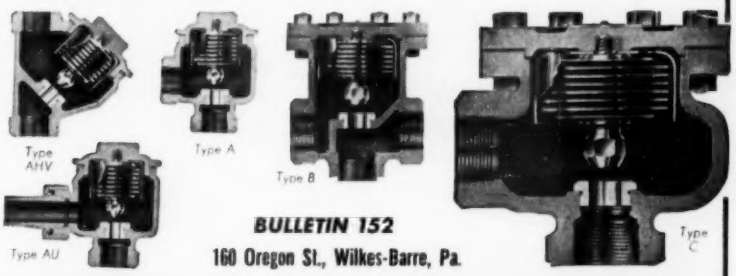


BULLETIN 152

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NEW HEAT SAVING EFFICIENCY

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- Attractive, Smooth Finish

Now available in pipe covering and block insulation, Mundet 85% Magnesia permits new heat-saving efficiency. Precision manufacturing on the latest type of automatic equipment insures uniform standards. Extra durability is built into the insulation. It does not "powder", settle or disintegrate. It is unaffected by either steam or water leakage. It maintains an attractive, smooth finish. Precision pipe fit is assured, with no spaces left for the escape of heat. You benefit from the most modern manufacturing facilities for the production of heat insulation. Write for specification information and recommendations. Mundet Cork Corporation, Insulation Division, 7115 Tonnelle Avenue, North Bergen, N. J.

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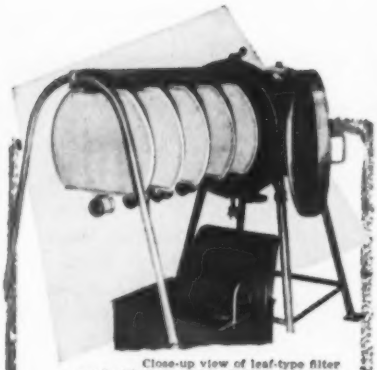

Close-up view of leaf-type filter used with Sorbo-Cel by Pullman-Standard

**How Pullman-Standard operates boilers on a**

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**with SORBO-CEL**

At the Haskell & Barker plant of Pullman-Standard Car Mfg. Co., Sorbo-Cel solved the major filtration problem of removing oil from condensate returned to the two new 50,000 lb-per-hr 400 psi, 750-F boilers.

Pre-Coat Sorbo-Cel and regular Sorbo-Cel, specially processed high flow-rate diatomaceous silica powders, are used on leaf-type filters. After a film of Pre-Coat Sorbo-Cel has been built up on the filter screens, regular Sorbo-Cel is added continuously to the unfiltered water. This means a new filter surface is constantly presented to the oncoming water.

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for Power Generation," consists of 41 pp on the instrumentation involved in generating stations. Separate sections cover steam generation instrumentation, turbine and generator instrumentation, electrical distribution instrumentation and diesel engine instrumentation. Measurement of temperature, pressure, flow, power generation and other variables discussed. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

**280 For Practical Men** — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester, justifies cost in long run economy. James G. Biddle Co.

**281 Industrial Thermometers** — Catalog 125, 28 pp, presents ordering data on a wide range of industrial thermometers, giving scale ranges, dimensions and prices. Features company's Adjust-Angle thermometer designed for use at any angle front to back, left or right, through a 180 deg arc. Gives construction details and advantages of this adjustable-stem type instrument. Weksler Thermometer Corp.

**282 Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

**283 Sight Glass Flow Indicators** — Twelve-pp Bulletin 18-W, on company's line of flow indicators, shows how these mechanical devices indicate fluid flow and its direction in pipelines which can be directly observed through a sight glass and are suitable for service with liquid, gas, vapor, slurry or sludge sufficiently translucent to permit observation of indicating element. Schutte and Koerting Co.

**284 How to Select Regulators** — This 36-pp, illustrated "step selection chart" simplifies choice of proper type and size of pressure regulator, temperature regulator or pump governor to do a specific job. Written in nontechnical language and supplemented by steam, gas and water capacity tables, this booklet includes installation suggestions, conversion tables and other data. Foster Engineering Co.

**285 Steam Specialties** — Catalog 53, 62 pp, describes a line of steam, gas, air, oil and water regulating equipment. Includes complete specifications, operational data and prices on pressure regulators, temperature regulators, combination pressure-temperature instruments, diaphragm valves, motor operated valves, float valves, safety and relief valves, strainers, solenoid and motor valves, water gages. Provides capacity tables, flange charts. O. C. Keckley Co.

**286 Instruments Control Systems** — Twelve-pp Catalog 513 presents manufacturer's line of instruments, control systems, regulating valves and desuperheaters. Covers draft and pressure instruments, boiler meters, recorders, thermometers, regulators, combustion controls, pump controls and many others. Republic Flow Meters Co.

**287 Boiler Control** — Ten-pp Bulletin 1007 describes a completely integrated system for controlling combustion, feed water, boiler steam temperature and boiler cleaning, available in a single package or

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Above units can be operated for inspection. All equipment is sold F.O.B. cars or trucks, Colorado Springs in "as is" condition, subject to inspection in Colorado Springs. Terms cash upon receipt of bill of lading and invoice. Write directly to Max W. Bowen, *Vice President and General Manager*, The Golden Cycle Corp., Colorado Springs, Colorado.

1 — Link-Belt Model #46 Vertical traveling "Clean Water" Intake screen 16'-6" centers, trays 72" wide with front spray. Capacity for screening 12,000 gallons water per minute at velocity of 1.9' per second through 100% clean screen cloth with water in screen at low level of 4'8". This is a new screen. It has never been used. Available for immediate shipment. For complete details and price WRITE: P. H. Glatfelter Co., Spring Grove, Pa.

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furnished separately. Illustrated with full color drawing of complete control, photos of recorders, drive unit. Covers instrumentation with both miniature and standard instruments. Copes-Vulcan Div., Continental Foundry & Machine Co.

**288 Panel Planning Ideas** — The engineering and economical planning of modern combustion and process control panels is discussed in 8-pp Bulletin 170. Numerous panel designs, fashioned for control, are illustrated along with the most up-to-date methods of tubing and wiring. A section on accessories helps make this a valuable source book of ideas for control station planners. Bailey Meter Co.

**289 Control Centers** — This 31-pp application booklet (B-5621) on control centers stresses the case for centralizing all controls of an entire system in one group of enclosures. Discusses the characteristics of control centers that make for flexibility of use, ease of servicing, safety. Three types are described, and the various electrical components that make up typical units are illustrated. A three-step building-block system of planning control centers is given. Westinghouse Electric Corp.

**290 For Combining Control Signals** — The improved design of company's Ratio Totalizer is described and pictured in 8-pp Bulletin 5452. This simplified versatile mechanism is a pneumatically operated control for combining input control pressures and spring forces, and producing an output control pressure based on addition, subtraction, multiplication, division or other functions. Hagan Corp.

**291 Control Equipment** — Catalog 003, 32 pp, presents company's equipment for the control of liquids and gases for water and sewage works, power and process industries. A well illustrated booklet, it lists many types of controllers, gages, manometers, valves, venturi tubes. Descriptions of the units, their operating characteristics, construction details, mountings, specifications and other data included. Simplex Valve & Meter Co.

## REFRACTORIES, INSULATION

**292 Refractory Cements** — Sixteen-pp Form 863, presenting a line of refractory cements, discusses the three basic materials used in them, provides a detailed selection guide and illustrated discussion on methods of preparation and installation. Also defines terminology. Norton Co.

**293 Heat Insulation Data** — This is a 12-pp illustrated engineering and specification manual describing applications for 85 per cent Magnesia heat insulation. Provides data on heat savings per pipe thickness, for heat ranges to 600 F. Includes charts for determining thickness standards for pipe covering, with tables for heat calculations. Mundet Cork Corp.

## OTHER EQUIPMENT

**294 The ABC of $CO_2$** — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of $CO_2$ in flue gases, $CO_2$ as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. The Hays Corp.

**295 Turbine Generators** — Bulletin H-18, 40 pp, covers turbine generators of 500 kw and above, pictures nearly 50 tur-

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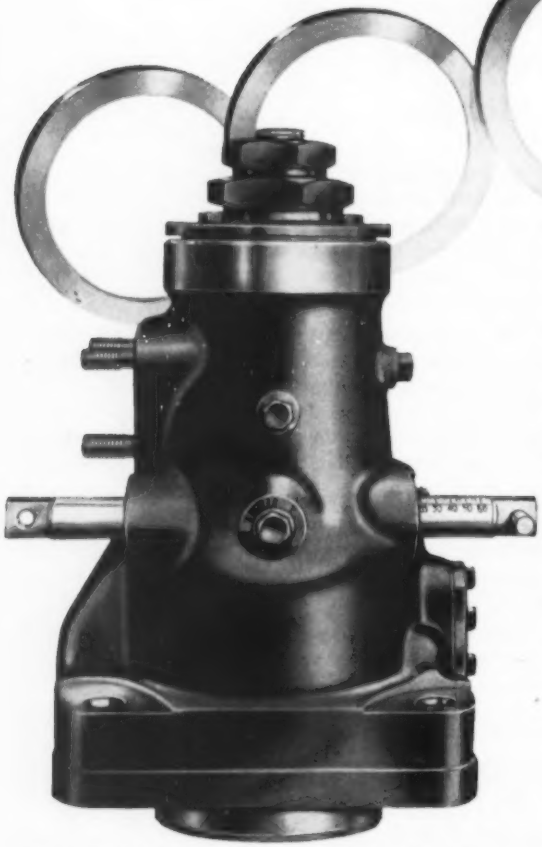

Diesel Fuel Injection Pump, made by American Bosch Corp., Springfield, Mass., and gaskets made by cutting rings off 2" deoxidized copper tube.

• An important extra service rendered by Revere consists of collaboration in setting up specifications. This is valuable because there are many different Revere Metals, each with special characteristics. No one copper, for example, will serve to best advantage in every application. A case in point is the matter of copper gaskets for Diesel fuel injection pumps. Copper is of course an ideal metal for gaskets, and is widely used for that purpose. But for this special application, which copper and in what form? The pump is used on large engines for municipal generating plants. It weighs 186 pounds, and must produce the high pressure required to inject fuel near the top of the Diesel compression stroke. Naturally, the load is a pulsating one. American Bosch Corporation came to Revere with the problem. Our suggestion was that much scrap could be saved if the gaskets were made by cutting rings off copper tube, instead of stamping them from strip. This achieved a double purpose, since the tube is made of deoxidized copper, which is superior in this application to electrolytic. We are able to report that these recommendations proved successful. . . . This work was done by the Revere Technical Advisory Service. To get in touch with it, see the nearest Revere Sales Office.

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bine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. A reference section offers detailed drawings showing a typical installation arrangement. Elliott Co.

**296 Mechanical Draft Fans** — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. The Green Fuel Economizer Co., Inc.

**297 Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

**298 Ejector Instruction Manual** — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Discusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles. Foster Wheeler Corp.

**299 Air Preheaters** — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's Ljungstrom preheater. The Air Preheater Corp.

**300 Motorized Chimney Draft** — The advantages of mechanical draft in supplying positive, uniform, adequate draft, regardless of variable weather conditions or inadequate chimney or breeching construction are shown in detail in Bulletin I-52. Also discusses other advantages, including eliminating need for tall stacks. L. J. Wing Mfg. Co.

**301 Chemical Cleaning Service** — Reduced maintenance costs and outage time are among advantages of company's chemical cleaning service for steam equipment and water lines discussed in this 8-pp bulletin. Before-and-after photos show some actual cleaning jobs and several case histories are given. Dowell Inc.

**302 Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

**303 Feedwater Heating System** — This bulletin describes a flash-type deaerating feedwater heating system offering flexibility in the use of steam at different levels. The Whitlock Mfg. Co.

**304 Equipment For Buildings and Institutions** — Bulletin WP-1099-B27M is a 20-pp revised booklet of condensed information on sizes, dimensions, capacities, ratings and features, of a wide range of equipment. Covers air conditioning and refrigeration products, with auxiliaries; oil, gas and dual fuel engines, deaerators and deaerating heaters; water conditionings; steam turbines and turbine generators; liquid meters; centrifugal and other pumps. Worthington Corp.


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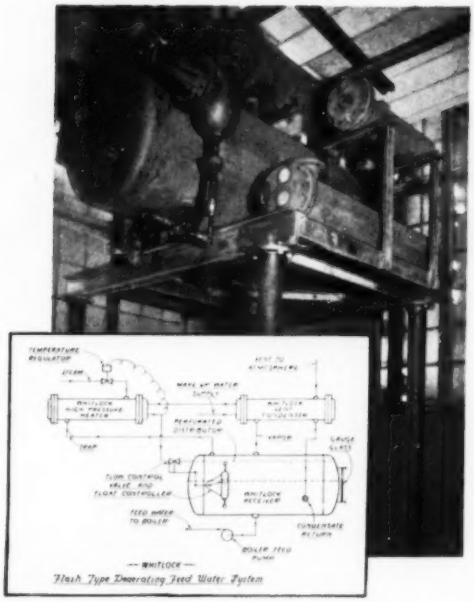
# Protect Your Boilers and Auxiliary Equipment






# WHITLOCK

## FLASH-TYPE DEAERATING FEEDWATER HEATING SYSTEM

The Whitlock Deaerating Feedwater Heating System is designed to do a definite, specific job — and to do it well. This system reduces destructive gas inclusions to the required minimum and thereby precludes corrosion of boiler tubes, steam lines and auxiliary equipment.

The Whitlock System is extremely flexible, allowing the use of steam at different levels. The amount of flash . . . and deaeration . . . is easily varied by adjustment of the temperature regulator. Simple construction, without internal complexities, keeps maintenance costs low. The Whitlock System has been developed in a full range of standard sizes to give optimum performance with all boilers from 50 to 2000 H.P.

*Write for new* Bulletin 120

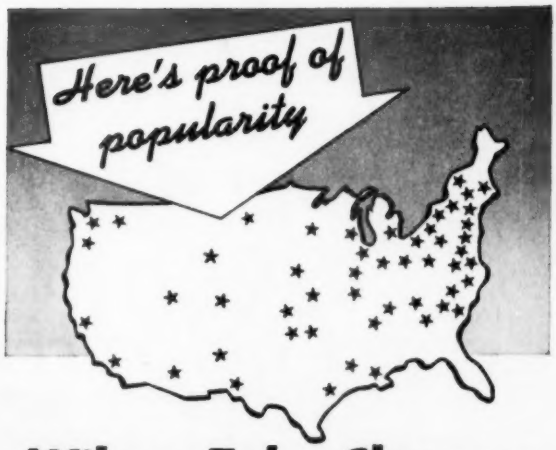
WHITLOCK EQUIPMENT

## *The* WHITLOCK MANUFACTURING CO.

47 South St., Hartford 10, Conn.

NEW YORK • BOSTON • CHICAGO • PHILADELPHIA • DETROIT • RICHMOND

For more data circle 598 on Post Card




# *Wilson Tube Cleaners and Expanders are* EVERYWHERE

For more than a quarter of a century, precision made Wilson tubular maintenance equipment has been serving American industry. Today, Wilson Tube Cleaners and Expanders are as near as your telephone. They are cutting downtime and saving maintenance costs in industrial and power plants all over the United States . . . and the world, too.

**WILSON TUBE CLEANERS** handle every kind of deposit—hard or soft, thick or thin or variable in depth. Powerful, fast-acting, they make quick work of cleaning straight or curved tubes from ⅜" to the largest ever cleaned. Wide range of cutter heads and accessories available.

**WILSON TUBE EXPANDERS** offer smooth, efficient rolling action which insures firm seating of the tube . . . provides perfectly rolled joints . . . reduces time-wasting re-rolling and re-inspection.

Yes, Wilsonize to economize. Follow the lead of thousands of industrial plants throughout America. Send for 48-page Bulletin on complete Wilson Tube Cleaner line and for Tube Expander Catalog. A single request brings both.

**Representatives in all principal cities**
**THOMAS C. WILSON, INC.**
21-11 44th AVE., LONG ISLAND CITY 1, N. Y.
**Cable address: "Tubeclean," New York**

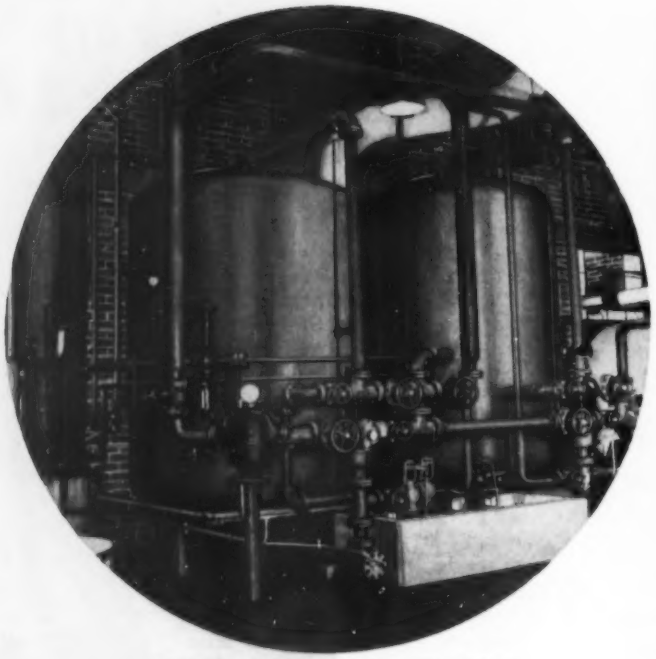
TW 821

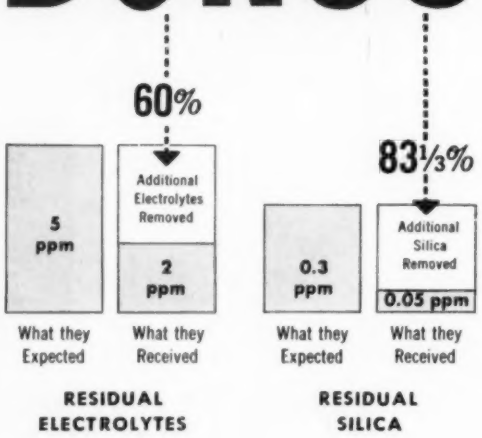
# WILSON

TUBE CLEANERS • TUBE EXPANDERS

For more data circle 599 on Post Card

# *How this Demineralizer delivered a* BONUS






**GRAVER EQUIPMENT IN THIS PLANT**

Two-bed demineralizer to treat 300 gpm of boiler feed make-up. Total capacity of softening plant per regeneration: 640,000 gallons, using Gravex ion exchange material. J. E. Sirrine Co., Consulting Engineers, selected Graver demineralizing equipment.

**GRAVER WATER CONDITIONING CO.**

*Division of Graver Tank & Mfg. Co., Inc.*

**216 WEST 14th STREET, NEW YORK 11, N. Y., Dept. PE-D**

In Canada: The Bird-Archer Co., Ltd., Cobourg, Ontario
In Mexico: Proveedores Tecnicos, S.A.; Puebla 259, Mexico 7, D. F.

If you wanted to reduce the total electrolytes in your raw water to *5 ppm*, and the demineralizing plant you installed actually reduced the electrolytes to *less than 2 ppm*, you'd have good reason to consider it a good investment.

And if, in addition, you expected the plant to reduce silica to *0.3 ppm*, and found that the silica was actually being reduced to *less than 0.05 ppm*, you'd have still more reason to consider that your demineralizer was delivering quite a bonus.

That's exactly what happened at the Riegel North Carolina Corporation's plant at Acme, N. C., without increasing the planned regenerant dosage. No wonder both the Company and its consultants consider the results very satisfactory.

To be sure of a completely satisfactory water conditioning plant for your own needs, get the benefit of Graver's 40 years of specialized experience.

**GRAVER Demineralizers**

GW 459

**For more data circle 600 on Post Card**

ARE YOUR LINES

# "Under the Hammer?"

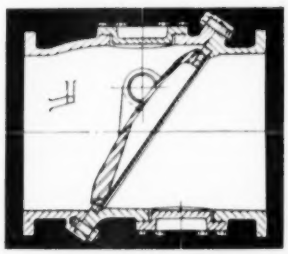
**. . . here's how to get them out from under with**

# CHAPMAN *Tilting Disc* CHECK VALVES

Loosened pipe-joints are caused by hammering. And hammering is caused by valve-slam. But when a valve can't slam under usual piping arrangements . . . then you're free from the danger of line damage.

And this is all because of the Chapman Tilting Disc, with specially designed airfoil section that means light weight, and perfect balance in the open position, so it is easily held open in the flow . . . and then dropped quietly to a *cushioned closing* that does not even jar the line.

That's why certified tests from the country's top engineering schools and actual installations prove that Chapman Tilting Disc Check Valves reduce head-loss over regular swing-type checks. Check these tests for yourself . . . write for Catalog No. 30.



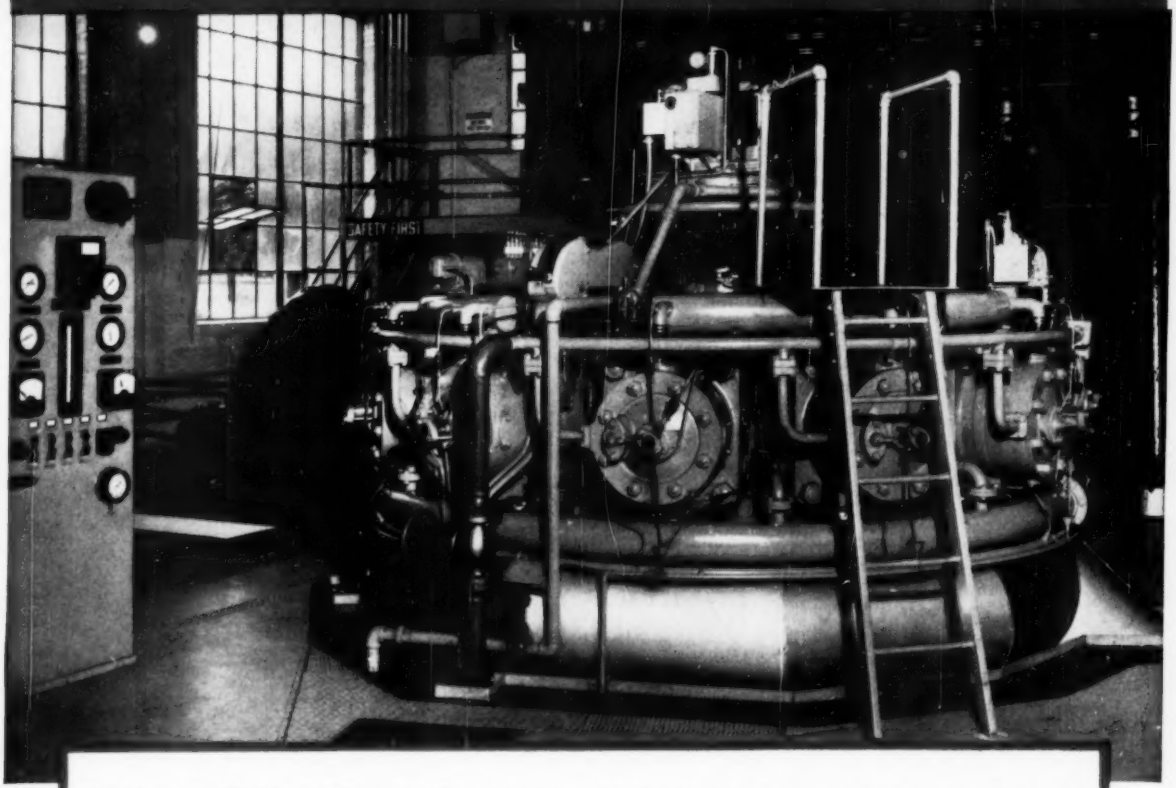
Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

## *The Chapman Valve Mfg. Co.*

**INDIAN ORCHARD, MASSACHUSETTS**

**For more data circle 601 on Post Card**

# "...SO MUCH BETTER LUBRICATION WITH TEXACO URSA OIL"




The Marshall (Michigan) Water and Electric Company started using *Texaco Ursa Oil* in two 5-cylinder Diesel engines in 1947. Results were so satisfactory — but read the story in the user's own words.

> "We got so much better lubrication with *Texaco Ursa Oil* — lower maintenance costs and fuel economy — that when we installed a new 6-cylinder Diesel in 1948 we naturally chose *Texaco Ursa Oil* to lubricate it. Same with the 11-cylinder radial Diesel we installed in 1951. As new Diesels go into our plant, you can be sure *Texaco Ursa Oil* is going in with them."

The Marshall Water and Electric Company's experience with *Texaco Ursa Oil* is typical. *Texaco Ursa Oil* is made for lubrication of Diesel, gas and dual-fuel engines. It stands up under toughest operating conditions . . . keeps rings free for proper compression and combustion, lower fuel consumption and lower maintenance costs. That is why —

> *For over 15 years, more stationary Diesel h.p. in the U.S. has been lubricated with Texaco than with any other brand.*

There is a complete line of Texaco Ursa Oils, approved by leading engine builders. A Texaco Lubrication Engineer will gladly help you select the proper one for your operation. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

# TEXACO URSA OILS

## FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

For more data circle 602 on Post Card